06

RECORD OF DECISION SUMMARY

BOWERS LANDFILL

CIRCLEVILLE, OHIO

March 24, 1989

U.S. Environmental Protection Agency

Region V

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

RECORD OF DECISION SUMMARY
BOWERS LANDFILL
CIRCLEVILLE, OHIO

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Bowers Landfill is located in rural Pickaway County, Ohio, approximately 2.5 miles north of the City of Circleville. The site is just northwest of the intersection of Island Road and Circleville - Florence Chapel Road, on the east side of the Scioto River Valley. The landfill lies within the Scioto River floodplain. Its northwestern and southern-most points abut the Scioto River (Figure 1).

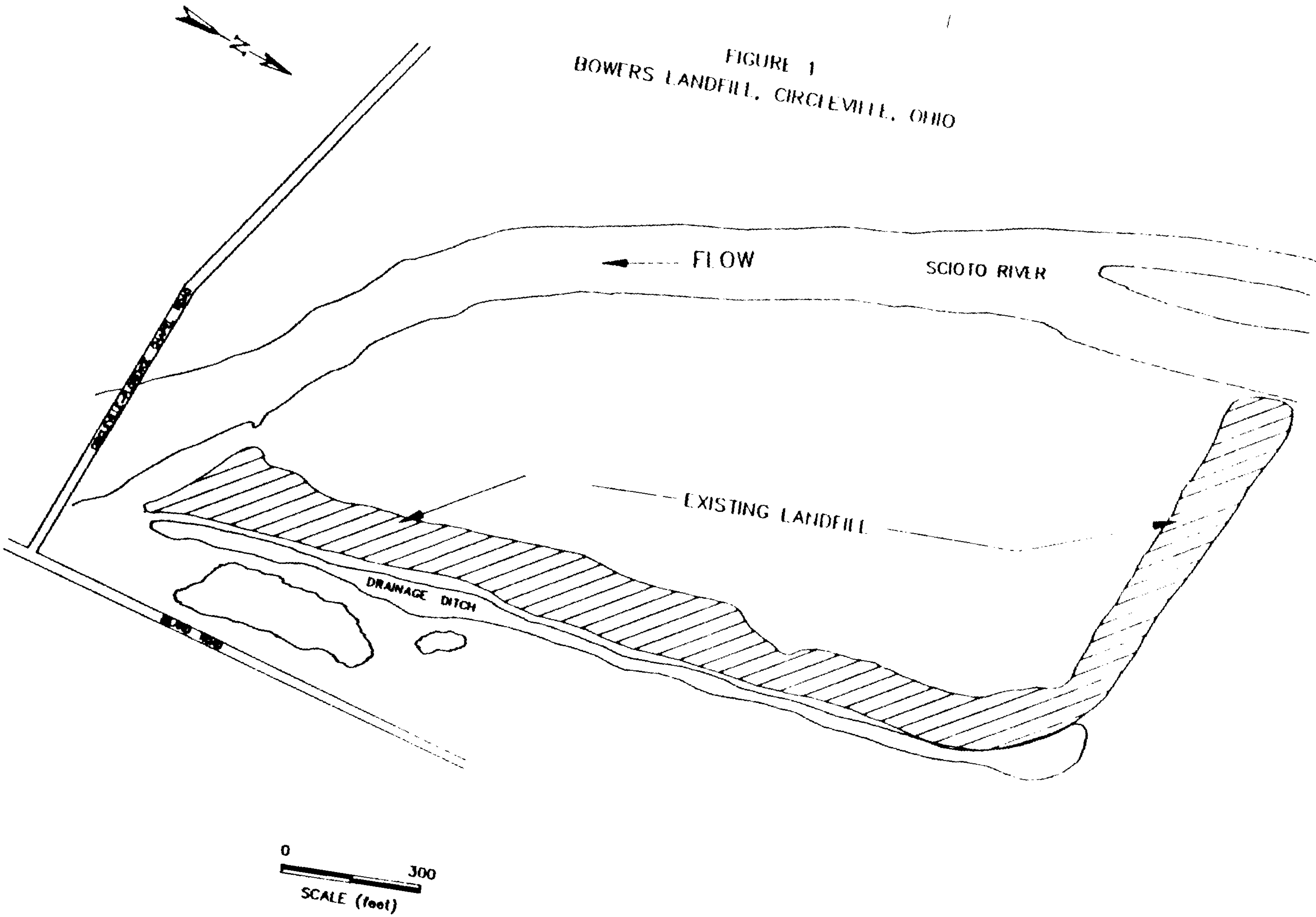
The landfill occupies about 12 acres of a 202-acre tract owned by the estate of Dr. John M. Bowers. The landfill was constructed as a berm approximately 4,000 feet long with an average width of 125 feet and a top height of approximately 10 feet above grade. The reported waste volume of the landfill is approximately 130,000 cubic yards. The landfill has an established cover of vegetation, including small trees, but miscellaneous debris is exposed where the landfill surface has been eroded. The area east of the site is a natural topographic high with the elevation on Island Road about 50 feet higher than the landfill. This topography has been modified by quarrying activities to the east and northeast of the site. The north and west sides of the landfill are bordered by agricultural fields.

Since the landfill lies within the Scioto River floodplain, it is flooded regularly. The field west of the landfill is inundated an average of 29 days per year, and parts of the landfill are overtopped by flood waters an average of every 2 years. Flood waters and precipitation generally flow west and south toward the Scioto River. A drainage ditch lies immediately east of the landfill. Water in this ditch flows through a pipe under the southern end of the landfill and discharges to the Scioto River. A ditch on the west side of the landfill is not well developed and does not discharge to the river. Water in this ditch tends to pond near the southern end of the landfill.

The site area is rural, with 15 houses located within a ½-mile radius of the landfill. Houses in this area largely depend on private wells for water supply. However, no downgradient wells are within 1 mile of the site. The City of Circleville's water supply wells are located about 1-1/2 miles south of the site.

A more complete description of the site can be found in the Remedial Investigation Report (dated August 22, 1988) and the Feasibility Study Report (dated February 3, 1989).

FIGURE 1
BOWERS LANDFILL, CIRCLEVILLE, OHIO



2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Dr. Bowers began operating the landfill in 1958. Little information is available on the types and quantities of wastes disposed of at Bowers Landfill. Much of the information was supplied by interviews with individuals familiar with landfill operations. However, these interviews were conducted 15 to 20 years after site operations ended. Information from Ohio EPA (OEPA) files indicates that residential type waste, collected by private haulers in and around Circleville, accounts for most of the material in Bowers Landfill. No industrial dumping at the site was reported before 1963. Between 1963 and 1968, in addition to general domestic and industrial refuse, the site received chemical wastes originating from local industries, including E.I. DuPont deNemours & Company (DuPont) and Pittsburgh Plate Glass, Inc. (now PPG Industries, Inc.). DuPont and PPG reported sending 6,000 and 1,700 tons of waste, respectively, to Bowers Landfill between 1965 and 1968.

Waste disposal practices consisted largely of dumping waste directly onto the ground and covering it with soil. However, there are some indications that the southern part of the landfill may have been excavated for waste disposal. Waste was also burned at the site; the extent and dates of waste burning are not known. Landfilling at the site ended around 1968. The site was not secured when landfilling ended, and the cover material of sand, gravel, and some topsoil was characterized as "not sufficient" during a 1971 inspection by the Pickaway County Health Department.

In 1980, U.S. EPA collected and analyzed surface water samples from the site area; the results indicated that some contaminants were being released from the landfill. U.S. EPA subsequently required Dr. Bowers to commission an environmental study of the site. During the study, three wells were installed to monitor ground-water quality. These and a number of existing private wells and surface water points near the site were sampled. Volatile organic compounds (VOC), including ethylbenzene, toluene, and xylene, were found in downgradient monitoring wells immediately west of the site. However, no VOCs were detected in an upgradient well east of the site.

In 1982, based on the levels of organic contaminants measured in water samples from the site, Ohio EPA (OEPA) requested that the site be placed on the National Priorities List (NPL) as a Superfund site. In 1985, U.S. EPA and OEPA signed a consent order with DuPont and PPG, two of the potentially responsible parties (PRP). This order outlined the scope and schedule for a remedial investigation (RI) and feasibility study (FS) at Bowers Landfill. DuPont and PPG have assumed responsibility for the site investigation. Dames & Moore, under contract to the PRPs, conducted the RI and FS.

RI field activities began in July 1986 and included two phases, a first phase to characterize contaminant levels at the site and a second phase to answer questions raised by the first phase. During the first phase, 18 monitoring wells were installed at or near the landfill and sampled twice. Ground water from four off-site residential wells was sampled once. Sediment and surface water were sampled twice, and surficial soils were sampled once. This first phase of sampling was completed in May 1987. The second phase of the RI was conducted during February and March 1988. The major purposes of the second phase were (1) to assess ground-water flow direction in the deeper of the two aquifers that underlie the site and (2) to collect additional ground-water and soil samples. Two additional monitoring wells were installed during the second phase, and five wells (including the two new wells) were sampled. In addition, soil samples were collected from 10 locations. Dames & Moore prepared a Remedial Investigation Report (dated August 22, 1988) describing these activities.

Dames & Moore began the FS in early 1988. The FS was based on the results from the RI and also on the results of an endangerment assessment (EA) prepared by a U.S. EPA contractor. Nine remedial alternatives for Bowers Landfill, including the "no action" alternative, were evaluated in the FS. Dames & Moore prepared a Feasibility Study Report (dated February 3, 1989) to describe the development and evaluation of these alternatives.

Following completion of the RI and FS, U.S. EPA sent a special notice letter to the PRPs on March 1, 1989. This letter indicates U.S. EPA's willingness to allow the PRPs to carry out the design and implementation of U.S. EPA's preferred remedial alternative for Bowers Landfill. During the FS process, both U.S. EPA and OEPA reviewed the PRPs' preference for a remedial alternative. However, for reasons outlined in this decision summary, U.S. EPA has selected a different alternative. Technical discussions between the agencies and the PRPs, concerning the selection of a remedial alternative, are summarized in the Administrative Record for Bowers Landfill.

3.0 COMMUNITY RELATIONS HISTORY

U.S. EPA has conducted an extensive community relations program in conjunction with the Bowers Landfill RI/FS. Between November 7, 1985, and November 2, 1988, 12 meetings of the Bowers Landfill Information Committee were held in Circleville, Ohio. The Information Committee consists of representatives from U.S. EPA, OEPA, the PRPs, local (city and county) government, and citizens' groups. These meetings were held at regular intervals to keep the public informed of progress during the RI/FS and to discuss upcoming events. During the meetings, U.S. EPA, OEPA, and the PRPs made formal presentations to the committee on topics such as well installation and sampling methods; sampling results for soil, ground water, surface water, and sediment; endangerment assessment results; applicable or relevant and appropriate requirements (ARARs); and remedial alternatives developed in the FS. Following the presentations, U.S. EPA, OEPA, and the PRPs discussed these topics with the committee and answered questions from committee members.

As part of its community relations program, U.S. EPA has maintained an information repository at the Pickaway County District Library, 165 East Main Street, Circleville, Ohio. All formal reports submitted by the PRPs during the Bowers Landfill RI/FS are available at this location. The information repository also contains reports prepared by U.S. EPA, such as the Endangerment Assessment Report and Proposed Plan for Bowers Landfill.

On September 14, 1988, U.S. EPA held a formal public meeting to present the results of both the Remedial Investigation and Endangerment Assessment Reports. This meeting was held at the Circleville High School Cafeteria, 380 Clark Drive, Circleville, Ohio.

Finally, U.S. EPA notified the local community, by way of the Proposed Plan, of the preliminary selection of a remedial alternative for Bowers Landfill. To encourage public participation in the selection of a remedial alternative, U.S. EPA scheduled a public comment period from February 14 to March 16, 1989. Additionally, U.S. EPA held a public meeting on February 28, 1989, to discuss the preferred remedial alternative, other alternatives evaluated in the FS, and any other documents previously released to the public. A transcript of this meeting is included as part of the Administrative Record for Bowers Landfill. U.S. EPA's responses to comments received during this public meeting and to written comments received during the public comment period are included in the Responsiveness Summary.

4.0 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The selected remedy for Bowers Landfill was developed by combining aspects of source control, site access restrictions, drainage improvements, and long-term monitoring. In summary, the selected remedy will include removing surface debris and vegetation from the landfill, installing a 4-foot-thick clay and soil cap on the landfill top and side slopes, instituting erosion control and drainage improvements, fencing the site perimeter and restricting site use, and conducting long-term ground-water monitoring. The components of the selected remedy are described in greater detail in Section 10.0.

The principal threats that the landfill poses are exposure to ground water immediately downgradient of the site and exposure to contaminated soils on or near the landfill. The selected remedy will address these threats by capping contaminated soils, limiting access to the landfill area, and restricting future ground-water use between the landfill and the Scioto River. Because wastes will remain on-site, the selected remedy will provide for long-term monitoring and corrective action measures should monitoring indicate increased contamination or threats. Also, as required by Section 121(c) of CERCLA, the site will be reevaluated each 5 years to determine whether the selected remedy is effective.

5.0 SITE CHARACTERISTICS

The remedial investigation (RI), consisting of on-site scientific studies and laboratory analyses to determine the nature and extent of contamination at the site, has been completed. The first phase investigation took place from July 1986 to May 1987. A second phase investigation was conducted in February and March 1988. During the RI, samples were taken of ground water, surface water, sediment, and soil. The results of the RI are summarized below.

5.1 Ground Water

The Bowers Landfill site is underlain by 40 to 100 feet of glacial deposits, which overlie shale bedrock. These glacial deposits are part of an extensive aquifer system that underlies the Scioto River floodplain. In the site area, glacial deposits thicken to the south and west of the site, and are thinnest at the northeast portion of the landfill. The glacial deposits include two water-bearing zones -- (1) a brown sand and gravel deposit that lies approximately 10 feet below the land surface and (2) a gray sand deposit with lesser amounts of gravel that lies just above the bedrock. These two zones are considered the upper and lower aquifers over most of the site and are separated by a low-permeability silt-clay deposit. However, the two aquifers may be hydraulically connected at some site locations. The bedrock below the glacial deposits is considered an aquiclude and is not used locally for water supply. Figure 2 illustrates an east-to-west geologic-cross section of the site area.

Dames and Moore installed 20 ground-water monitoring wells at the site. These included 10 shallow wells, 5 intermediate wells, and 5 deep wells (Figure 3). Shallow wells were screened at the water table near the top of the upper aquifer. Intermediate wells were screened within the lower portion of the upper aquifer. Deep wells were screened within the lower aquifer. A comparison of ground-water levels for each series of wells (shallow, intermediate, and deep) indicated that ground water near the site is moving west or southwest.

FIGURE 2

GEOLOGIC CROSS-SECTION OF THE SITE AREA

BOWERS LANDFILL - CIRCLEVILLE, OHIO

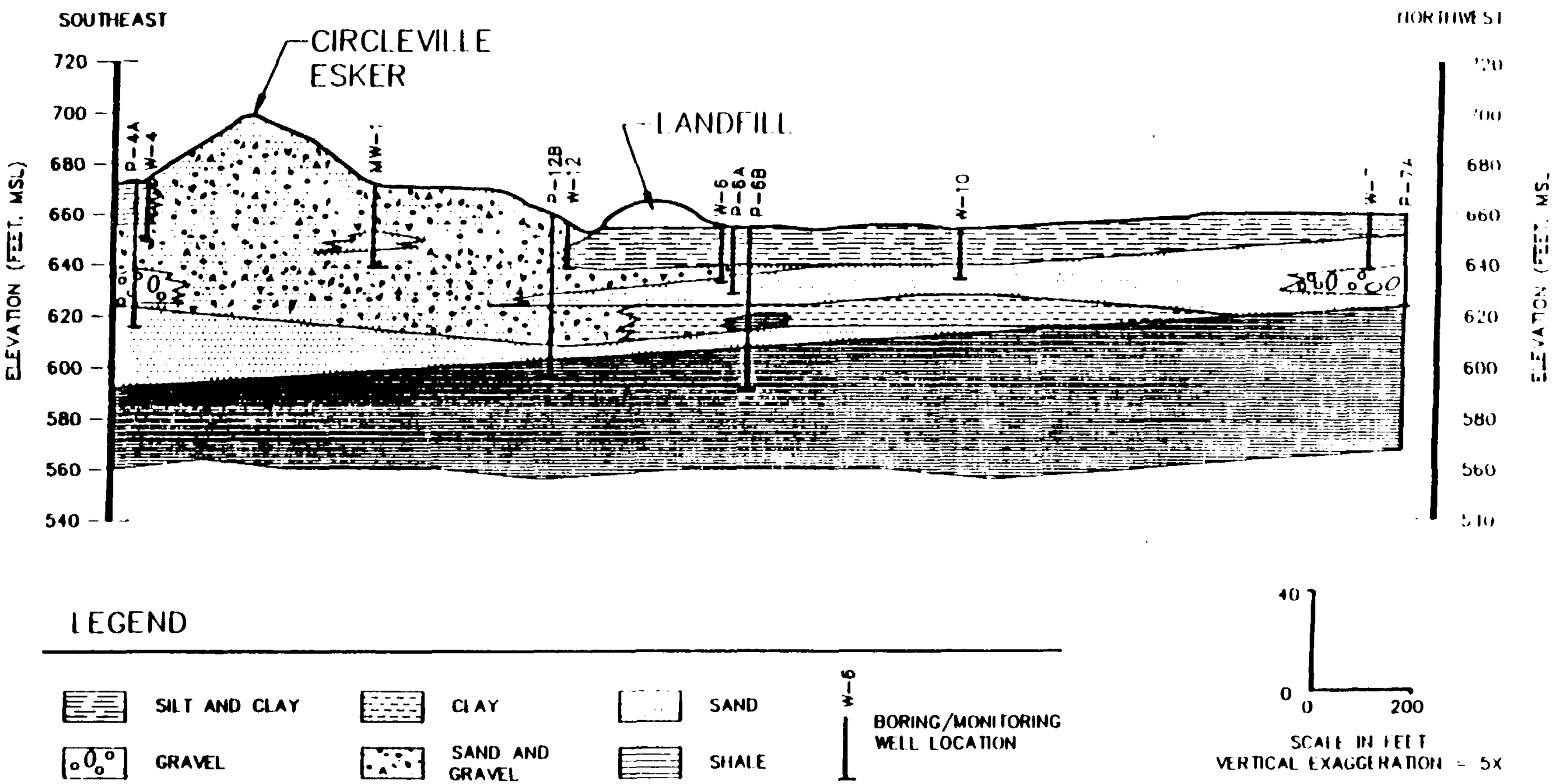
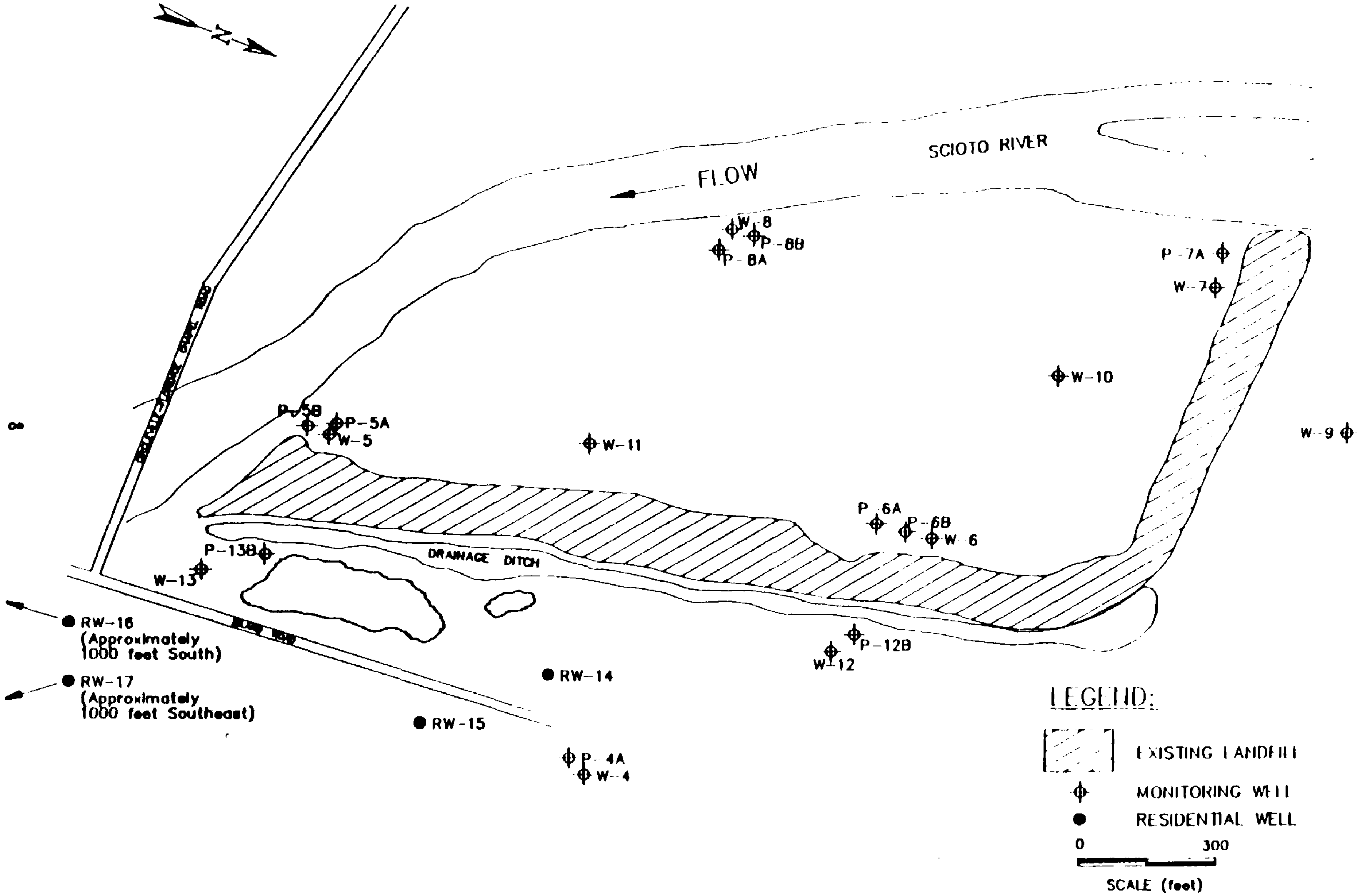


FIGURE 3. -- LOCATIONS OF WELLS SAMPLED



Ground-water samples were collected from 18 monitoring wells in February 1987 and May 1987 (Figure 3). Samples were also collected from four residential wells in February 1987. Two additional monitoring wells were installed in February 1988. These wells and three of the original 18 wells were sampled in March 1988. All samples were analyzed for VOCs, semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), metals, and cyanide. Samples collected in February and May 1987 were also analyzed for dioxin.

VOCs including acetone, methylene chloride, tetrachloroethene, and benzene were detected at low concentrations in some ground-water samples taken from monitoring wells at or near the site. In all, 9 of the 20 monitoring wells contained VOCs in at least one sample. Most of these positive results were due to acetone and methylene chloride, common laboratory contaminants. Benzene and tetrachloroethene were found in one well each. Benzene was found in well P-6B, downgradient of the landfill, in two of three sampling rounds. The highest concentration detected was 6 μg/L, slightly above the U.S. EPA drinking water standard of 5 μg/L. Tetrachloroethene was found in upgradient well W-12 both times this well was sampled. The maximum concentration detected was 5.3 μg/L.

Bis(2-ethylhexyl)phthalate, a SVOC, was detected in several ground-water samples. Three other SVOCs, di-n-butyl phthalate, 2-methylnaphthalene, and n-nitrosodiphenylamine, were found in one sample each. All of these chemicals except one (bis(2-ethylhexyl)phthalate at 21 μg/L in well P-7A) were identified at levels below U.S. EPA-specified detection limits. No SVOCs were detected in residential well samples.

A number of metals were also detected in ground-water monitoring and residential wells. All levels except those for barium were below U.S. EPA drinking water standards. Barium was detected above drinking water standards in all three samples collected from well P-5B. This well is screened in the lower aquifer near the south end of the site. Since barium was detected in all ground-water samples, including samples from residential wells, some portion of the barium found in well P-5B may be due to natural sources.

Residential wells do not appear to be affected by releases from the site. Methylene chloride, a common laboratory contaminant, was the only organic compound found in residential wells, and no metals were detected above drinking water standards. In addition, sampling results from the Circleville municipal well field, located 1-1/2 miles south of the landfill, show that the well field has not been affected by Bowers Landfill. Ground-water contamination resulting from the landfill appears to be confined to the area between the landfill and the Scioto River. The Scioto River is the likely discharge point of these contaminated ground waters. Thus, the impact of contaminated ground water appears limited.

5.2 Surface Water and Sediment

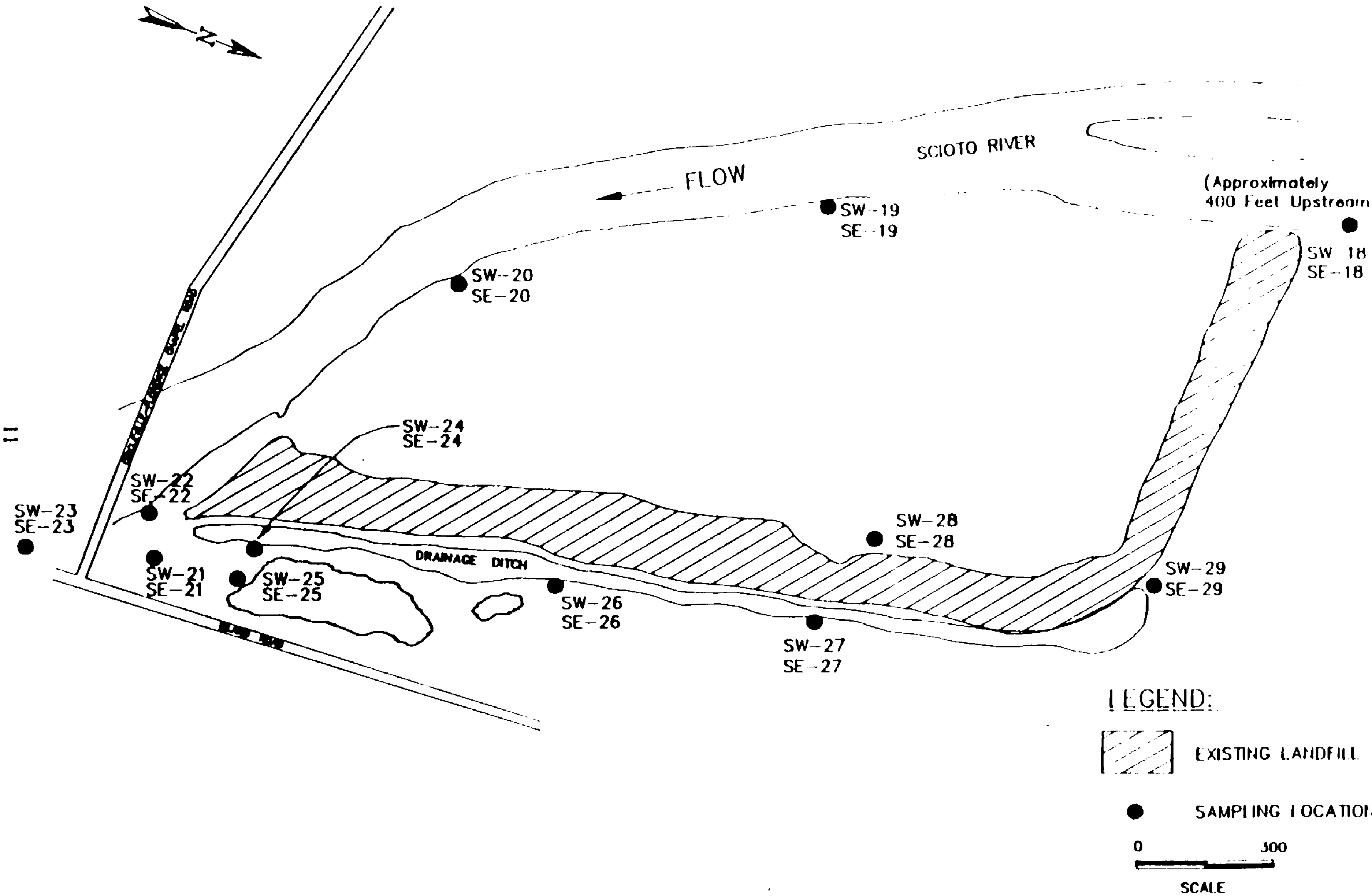
Surface water and sediment samples were collected from 12 locations in the Scioto River and nearby surface water bodies. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, and dioxin. Samples were collected from all locations shown on Figure 4 during two sampling events.

Methylene chloride (5 samples), tetrachloroethene (3 samples), and 1,2-dichloroethane (2 samples) were found at low levels (up to 5.7 $\mu g/L$) in the river downstream of the landfill or in drainage ditches near the landfill. However, methylene chloride and tetrachloroethene were found at similar concentrations in upstream background samples. Aroclor-1260, a PCB, was found in two surface water samples collected from the Scioto River, one upstream and one downstream. Several metals were also detected in surface water samples. However, many of these metals occur naturally. Aluminum, barium, chromium, and mercury were found above upstream background concentrations in at least one sample each.

Several SVOCs were detected in sediment samples collected from the Scioto River and drainage ditches near the site. These include polynuclear aromatic hydrocarbons (PAH), phthalate compounds, 4-methylphenol, chlordane, and PCBs. PAHs and phthalates were also found at similar concentrations in upstream background samples. PCBs were detected at three locations in drainage ditches adjacent to the landfill (SE-27, SE-28, and SE-29) and appear to have originated from the site. The maximum concentration detected was 2,300 $\mu g/kg$. Chlordane, a pesticide, was found at concentrations ranging from 120 to 200 $\mu g/kg$ in three locations. All three locations (SE-20, SE-21, and SE-22) were in or adjacent to the Scioto River, near the southern end of the landfill. While chlordane may be associated with landfilling, the occurrence of this pesticide could also be due to agricultural activities in the field west of the landfill. The occurrence of 4-methylphenol appears to be concentrated near the southern end of the landfill and the drainage ditch to the east. This SVOC was found in seven sampling locations, with a maximum concentration of 8,600 $\mu g/kg$ at SE-22.

Several metals were found above background levels in sediment samples. These include aluminum, barium, cadmium, chromium, lead, mercury, vanadium, and zinc. However, these metals were found at elevated levels in only a few (no more than four) sampling locations at various locations on the landfill.

FIGURE 4. — SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS



11

5.3 Soils

Surface soil samples were collected from 22 locations in September 1986. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, and dioxin. Additional soilsamples were collected in March 1988 as part of the second phase of the RI. Ten locations were sampled, including seven new locations. This second round of soil samples was analyzed only for arsenic and lead. In all, 29 locations were sampled, including 7 off-site locations. Figure 5 shows the soil sampling locations.

Three pesticides (ß-BHC, dieldrin, and chlordane) were found in soil samples. The pesticides were found at two locations in the field west of the landfill (SO-7 and SO-11), one location at the western end of the landfill (SO-35), and one location south of the landfill (SO-44). The maximum concentration detected was 210 μg/kg of chlordane at locations SO-35 and SO-44. The presence of these pesticides in the field west of the landfill could be due to past agricultural activities.

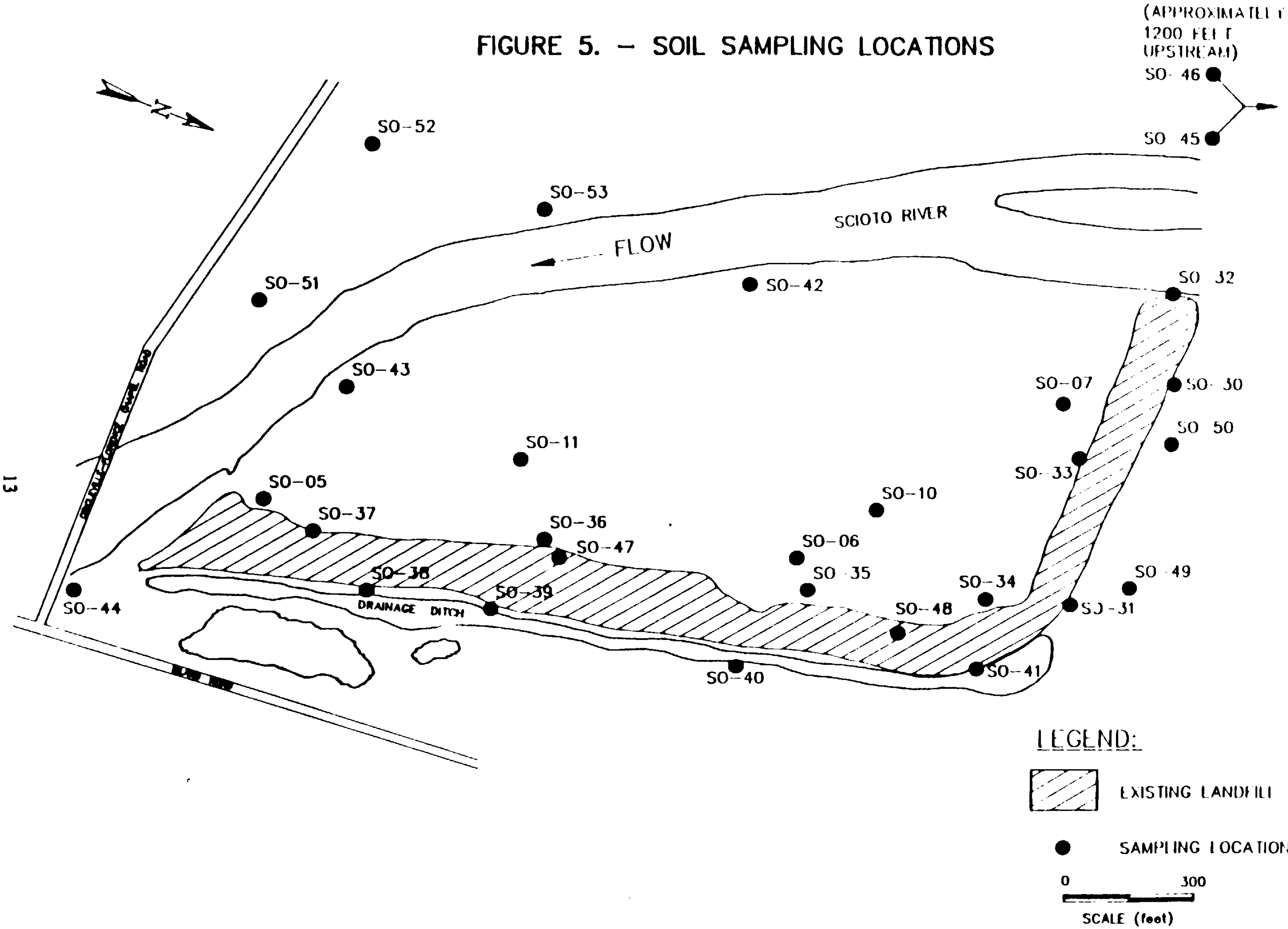
Three PCB compounds (Aroclors 1242, 1248, and 1254) were detected in soil samples at nine locations. Eight of these locations are on or directly adjacent to the landfill, with six of the locations clustered near the northeast corner of the landfill. Thus, the presence of PCBs appears to be related to landfilling activities. The highest concentration, 3,600 μg/kg, was found at location SO-34.

In the first round of soil samples, several metals were found near the landfill at concentrations higher than off-site background levels. These include aluminum, arsenic, cobalt, lead, vanadium, and zinc. A second round of soil samples was collected and analyzed for arsenic and lead to determine whether these metals might be related to landfilling activities. The combined results from the two rounds indicated that soil arsenic levels were similar for samples collected on the landfill, in the agricultural fields directly west and north of the landfill, and from locations west of the Scioto River. However, the results for lead indicated that soil samples collected from the landfill had slightly higher concentrations. The maximum lead concentration, 179 mg/kg, was found at location SO-35.

5.4 Air

No quantitative air samples were collected during the RI at Bowers Landfill. Thus, the extent of air contamination at the site is not known. However, air monitoring was conducted during the RI for VOCs, radiation, and combustible gases. On-site concentrations were not elevated above background levels.

FIGURE 5. – SOIL SAMPLING LOCATIONS



Bowers Landfill has a low potential for VOC emissions to air because very few VOCs were found in surface soils, surface water, or sediments. Other contaminants found in surface soils, such as PCBs, PAHs, and metals, could become airborne if dust is released from the landfill surface. However, the site is currently covered with vegetation and has very little exposed soil.

6.0 SUMMARY OF SITE RISKS

PRC Environmental Management, Inc., under contract to U.S. EPA (No. 68-01-7331), conducted an endangerment assessment (EA) for Bowers Landfill. This section summarizes the findings of the EA and characterizes site risks.

6.1 Indicator Chemicals

The EA used standard U.S. EPA procedures, as outlined in the Superfund Public Health Evaluation Manual, to identify indicator chemicals for Bowers Landfill. The EA focused on potential exposure to and risks from these chemicals. The indicator chemicals were generally those contaminants that exhibited the most toxic properties, were found in several environmental media, or were detected at the greatest frequency.

The indicator chemicals included three metals (barium, lead, and mercury); two VOCs (benzene and tetrachloroethene); two SVOCs (4-methylphenol and PAHs); PCBs; and one pesticide (chlordane). The EA evaluated PAHs as a class of chemicals, focusing on those PAHs that are known or suspected carcinogens. Tables 1 through 4 identify the detection frequencies and concentrations (mean and maximum) of indicator chemicals in samples collected during the RI. Results are organized by environmental medium (ground water, surface water, sediments, and soil).

6.2 Exposure Assessment and Risk Characterization

The indicator chemicals identified in various environmental media during the RI were evaluated to determine the level of risk they pose to public health and the environment. The EA identified 10 potential exposure scenarios for contaminants at or released from Bowers Landfill. Potential risks for each scenario were characterized for human and animal populations that could become exposed.

The EA concluded that potential risks existed under 5 of the 10 scenarios evaluated. These exposure scenarios include ingestion of ground water; ingestion of surface water; ingestion

TABLE 1

DETECTION FREQUENCIES AND CONCENTRATIONS OF INDICATOR CHEMICALS IN GROUND WATER NEAR BOWERS LANDFILL

	Upgradient Wells				Downgradient Wells				Residential Wells			
Compound	Frequency of Detection[1]	Adjusted Frequency of Detection[2]	Geometric Mean (ug/L)	Maximum Concentration (ug/L)	Frequency of Detection	Adjusted Frequency of Detection	Geometric Mean (ug/L)	Maximum Concentration (ug/L)	Frequency of Detection	Adjusted Frequency of Detection	Geometric Mean (ug/L)	Maximum Concentration (ug/L)
Barium	16/16	16/16	185	368	37/37	37/37	330	2070	5/5	5/5	112	[130]
Lead	2/16	1/15	1.2	7.0	8/37	1/27	1.2	6.9	0/5	—	—	—
Mercury	2/16	0/16	—	—	0/37	—	—	—	0/5	—	—	—
Benzene	0/16	—	—	—	3/37	3/37	0.70	6.0	0/5	—	—	—
Tetrachloroethene	3/16	3/16	0.89	5.3	0/37	—	—	—	0/5	—	—	—
Chlordane	0/16	—	—	—	0/37	—	—	—	0/5	—	—	—
PCBs	0/16	—	—	—	0/37	—	—	—	0/5	—	—	—
4-Methylphenol	0/16	—	—	—	0/37	—	—	—	0/5	—	—	—
PAHs	0/16	—	—	—	0/37	—	—	—	0/5	—	—	—

Notes:

[ ] Estimated value; compound found at concentration below U.S. EPA required detection limit

— Not calculated

1 Frequency of detection is defined as a/b, where –
a = number of times a compound was detected
b = total number of samples
Sample results which were identified by the laboratory as due to blank contamination are not counted in either a or b.

2 Adjusted frequency of detection omits samples from which results were questionable due to QA/QC problems; only samples included in this column were used to determine geometric mean and maximum concentrations.

TABLE 2

DETECTION FREQUENCIES AND CONCENTRATIONS OF INDICATOR CHEMICALS IN SURFACE WATER NEAR BOWERS LANDFILL

Compound	Scioto River - Upstream				Scioto River - Downstream				Drainage Ditches			
	Frequency of Detection[1]	Adjusted Frequency of Detection[2]	Geometric Mean (ug/L)	Maximum Concentration (ug/L)	Frequency of Detection	Adjusted Frequency of Detection	Geometric Mean (ug/L)	Maximum Concentration (ug/L)	Frequency of Detection	Adjusted Frequency of Detection	Geometric Mean (ug/L)	Maximum Concentration (ug/L)
Barium	2/2	2/2	56	[60]	9/9	9/9	54	[60]	19/19	19/19	101	[199]
Lead	1/2	0/1	—	—	4/9	0/5	—	—	4/19	1/15	1.3	8.6
Mercury	0/2	—	—	—	2/9	1/3	0.13	0.20	1/19	1/5	0.12	0.27
Benzene	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—
Tetrachloroethene	1/2	1/2	0.74	1.1 J	2/9	2/9	0.59	1.1 J	0/19	—	—	—
Chlordane	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—
PCBs	1/2	1/2	0.77	1.2	0/9	—	—	—	1/19	1/19	0.55	2.6
4-Methylphenol	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—
PAHs	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—

Notes:

[ ], J Estimated value; compound found at concentration below U.S. EPA required detection limit

— Not calculated

1 Frequency of detection is defined as a/b, where –
 a = number of times a compound was detected
 b = total number of samples
 Sample results which were identified by the laboratory as due to blank contamination are not counted in either a or b.

2 Adjusted frequency of detection omits samples from which results were questionable due to QA/QC problems; only samples included in this column were used to determine geometric mean and maximum concentrations.

TABLE 3

DETECTION FREQUENCIES AND CONCENTRATIONS OF INDICATOR CHEMICALS IN SEDIMENTS NEAR BOWERS LANDFILL

Compound	Scioto River – Upstream: Frequency of Detection[1]	Scioto River – Upstream: Adjusted Frequency of Detection[2]	Scioto River – Upstream: Geometric Mean (mg/kg)	Scioto River – Upstream: Maximum Concentration (mg/kg)	Scioto River – Downstream: Frequency of Detection	Scioto River – Downstream: Adjusted Frequency of Detection	Scioto River – Downstream: Geometric Mean (mg/kg)	Scioto River – Downstream: Maximum Concentration (mg/kg)	Drainage Ditches: Frequency of Detection	Drainage Ditches: Adjusted Frequency of Detection	Drainage Ditches: Geometric Mean (mg/kg)	Drainage Ditches: Maximum Concentration (mg/kg)
Barium	2/2	2/2	113	118	9/9	9/9	106	312	19/19	19/19	128	227 E
Lead	2/2	2/2	31	38	9/9	8/8	34	39	19/19	15/15	39	104
Mercury	2/2	1/1	—	0.40	9/9	4/4	0.48	0.59	10/19	6/15	0.14	1.4
Chlordane	0/2	—	—	—	2/9	2/9	0.067	0.200	2/19	2/19	0.055	0.140
PCBs	0/2	—	—	—	0/9	—	—	—	5/19	5/19	0.105	2.300
Benzene	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—
Tetrachloroethene	0/2	—	—	—	0/9	—	—	—	0/19	—	—	—
4-Methylphenol	0/2	—	—	—	2/9	2/9	0.069	8.600	7/19	7/19	0.091	8.100
PAHs												
Benzo(a)anthracene	2/2	2/2	0.415	0.420 J	8/9	8/9	0.256	3.600	11/19	11/19	0.072	0.400 J
Benzo(a)pyrene	2/2	2/2	0.408	0.450 J	9/9	9/9	0.217	0.370 J	11/19	11/19	0.077	0.400 J
Benzo(b)fluoranthene	2/2	2/2	0.900	0.910	9/9	9/9	0.451	0.750	13/19	13/19	0.137	1.000
Chrysene	2/2	2/2	0.519	0.550	9/9	9/9	0.287	0.480	12/19	12/19	0.095	0.710 J
Dibenzo(a,h) anthracene	2/2	2/2	0.116	0.160 J	1/9	1/9	0.030	0.130 J	1/19	1/19	0.027	0.092 J
Indeno(1,2,3-cd) pyrene	2/2	2/2	0.275 J	0.290 J	5/9	5/9	0.064	0.250 J	8/19	8/19	0.049	0.270 J

Notes:

J Estimated value; compound found at concentration below U.S. EPA required detection limit

E Concentration is estimated due to presence of interference during analysis

— Not calculated

1 Frequency of detection is defined as a/b, where –
  a = number of times a compound was detected
  b = total number of samples
  Sample results which were identified by the laboratory as due to blank contamination are not counted in either a or b.

2 Adjusted frequency of detection omits samples from which results were questionable due to QA/QC problems; only samples included in this column were used to determine geometric mean and maximum concentrations.

TABLE 4

DETECTION FREQUENCIES AND CONCENTRATIONS OF INDICATOR CHEMICALS
IN SOILS NEAR BOWERS LANDFILL

Compound	Background Locations: Frequency of Detection[1]	Background Locations: Adjusted Frequency of Detection[2]	Background Locations: Geometric Mean (mg/kg)	Background Locations: Maximum Concentration (mg/kg)	Locations On or Adjacent to the Landfill: Frequency of Detection	Locations On or Adjacent to the Landfill: Adjusted Frequency of Detection	Locations On or Adjacent to the Landfill: Geometric Mean (mg/kg)	Locations On or Adjacent to the Landfill: Maximum Concentration (mg/kg)	Agricultural Areas: Frequency of Detection	Agricultural Areas: Adjusted Frequency of Detection	Agricultural Areas: Geometric Mean (mg/kg)	Agricultural Areas: Maximum Concentration (mg/kg)
Barium	2/2	2/2	152	156	15/15	15/15	189	287	7/7	7/7	121	198
Lead	5/5	5/5	47	74 E	21/21	21/21	78	179	11/11	11/11	59	102 E
Mercury	2/2	0/2	—	—	15/15	15/15	0.27	0.43	7/7	2/2	0.48	0.58
Chlordane	0/2	—	—	—	2/15	2/15	0.015	0.210	1/7	1/7	0.014	0.110
PCBs	0/2	—	—	—	9/15	9/15	0.238	3.600	1/7	1/7	0.063	0.240
Benzene	0/2	—	—	—	0/15	—	—	—	0/7	—	—	—
Tetrachloroethene	0/2	—	—	—	0/15	—	—	—	0/7	—	—	—
4-Methylphenol	0/2	—	—	—	0/15	—	—	—	0/7	—	—	—
PAHs												
Benzo(a)anthracene	2/2	2/2	0.130	0.140 J	14/15	14/15	0.116	4.300	6/7	6/7	0.081	0.210 J
Benzo(a)pyrene	2/2	2/2	0.134	0.150 J	12/15	12/15	0.115	4.300	5/7	5/7	0.088	0.230 J
Benzo(b)fluoranthene	2/2	2/2	0.265	0.280 J	11/14	11/14	0.178	8.600	7/7	7/7	0.204	0.510
Chrysene	2/2	2/2	0.160	0.160 J	14/15	14/15	0.169	5.200	7/7	7/7	0.136	0.240 J
Dibenzo(a,h) anthracene	0/2	—	—	—	1/15	1/15	0.026	0.960 J	0/7	—	—	—
Indeno(1,2,3-cd) pyrene	1/2	1/2	0.047	0.110 J	11/15	11/15	0.073	2.600	4/7	4/7	0.054	0.160 J

Notes:

J Estimated value; compound found at concentration below U.S. EPA required detection limit

E Concentration is estimated due to presence of interference during analysis

— Not calculated

1 Frequency of detection is defined as a/b, where –
  a = number of times a compound was detected
  b = total number of samples
  Sample results which were identified by the laboratory as due to blank contamination are not counted in either a or b.

2 Adjusted frequency of detection omits samples from which results were questionable due to QA/QC problems; only samples <u>included</u> in this column were used to determine geometric mean and maximum concentrations.

of aquatic animals; ingestion of soils; and direct contact with surface water. The first four scenarios apply to humans living near Bowers Landfill while the fifth scenario applies to aquatic species living in the Scioto River near the landfill. The potential risks associated with each scenario are summarized in Table 5 and discussed below.

6.2.1 Ingestion of Ground Water

The EA identified a potential risk from drinking ground water immediately downgradient of the landfill. The area included in this scenario is the field between the landfill and the Scioto River. Ground water in this area contains barium (a noncarcinogen) and benzene (a carcinogen) at concentrations above U.S. EPA Maximum Contaminant Levels (MCL) for drinking water. However, each contaminant exceeded the standard in only one well; samples from all other wells contained barium and benzene concentrations well below MCLs.

The EA assumed that a 70-kg adult would drink 2 liters of ground water per day over a 70-year lifetime. Probable case doses from this exposure were calculated using average barium and benzene concentrations in downgradient ground water (Table 1). Worst case doses were calculated from maximum concentrations. The EA then used these doses to estimate potential risks. Noncarcinogenic risks were estimated by calculating a Hazard Index (HI), the ratio of the exposure dose to the acceptable chronic intake for barium. This ratio was 1.04 for the maximum barium concentration, indicating that the estimated dose exceeded the acceptable dose. Probable case risks were much lower, with the HI equal to 0.17. Carcinogenic risks for benzene were estimated by multiplying the exposure dose by the carcinogenic potency factor (CPF). For worst case exposure conditions, this risk was 9×10^{-6}; the probable case risk was 1×10^{-6}.

Although these risks are significant, exposure is unlikely to occur. Ground water downgradient of the site, between the landfill and the Scioto River, is not currently used as a drinking water source. Further, this area is often flooded and is not a likely location for future drinking water wells.

In addition to these potential future risks, the EA looked at risks to current users of ground water near Bowers Landfill. All existing residential wells near the site are upgradient. Four residential wells were sampled during the RI and showed no effects of the landfill on water quality (Table 1). The City of Circleville water supply is also of concern. Circleville obtains its municipal water supply from a wellfield approximately 1½ miles south of the site. However, the RI study of the area south of the landfill was limited. The EA considered the possibility of regional ground-water flow to the south, along the Scioto River basin. To investigate this possibility, the EA reviewed water quality sampling data submitted by the city to the Ohio

TABLE 5

SUMMARY OF POTENTIALLY SIGNIFICANT RISKS IDENTIFIED FOR BOWERS LANDFILL

Exposure Route	CA/NCA[1]	Contaminants	Risk Assessment	Comments
1. Ingestion of Ground Water	NCA	Barium	Hazard Index[2] = 1.04	While based on the maximum barium concentration, the hazard index only slightly exceeds unity. Therefore, the actual noncarcinogenic risk via this scenario is probably very small.
	CA	Benzene	Incremental Carcinogenic risk = 9×10^{-6} (worst case), 1×10^{-6} (probable case)	The incremental carcinogenic risks for benzene are within the target range of 10^{-4} to 10^{-7} (see footnote No. 3).
2. Ingestion of Surface Water	CA	PCBs	Maximum PCB concentration in the drainage ditches (2.6 ug/L) exceeds the ambient water quality criterion (AWQC) for consumption of drinking water. This AWQC (0.013 ug/L) corresponds to a 10^{-6} cancer risk.	The AWQC for PCBs assumes lifetime exposure while this scenario assumes infrequent incidental ingestion; therefore, this comparison overestimates the actual risk.
3. Ingestion of Aquatic Animals	NCA	Mercury	The maximum mercury concentration (0.2 ug/L) exceeds the AWQC based on ingestion of aquatic animals (0.146 ug/L).	Tissue samples have not been taken to verify the extent of this exposure. However, average mercury concentrations were below the AWQC and mercury was found in only one surface water sample from the Scioto River. Thus, this risk is limited.
4. Ingestion of Soils	NCA	Lead	Hazard Index = 3.20	This hazard index may overestimate the actual risk because it assumes both the maximum lead concentration and a worst case soil ingestion rate. Further, lead levels in on-site soils are below Centers for Disease Control (CDC) guidelines for residential areas.
	CA	Total PAHs[4]	Incremental Carcinogenic Risk = 2×10^{-6}	These two risks may overestimate the actual risk because they are based on maximum concentrations and a worst case soil ingestion rate. See also Footnote No. 3.
		PCBs	Incremental Carcinogenic Risk = 7×10^{-7}	
5. Direct Contact with Surface Water by Aquatic Animals	NCA	Mercury	Maximum mercury concentration (0.2 ug/L) exceeds the 4-day AWQC for protection of aquatic life (0.012 ug/L).	Actual risk may be negligible based on average mercury concentrations. Further mercury was found in only one surface water sample from the Scioto River.

Notes:

1 CA = Carcinogenic
NCA = Noncarcinogenic

2 The hazard index (HI) is calculated as the ratio of exposure dose to acceptable dose; an HI > 1 indicates a potentially significant risk.

3 U.S. EPA guidance describes a target carcinogenic risk range of 10^{-4} to 10^{-7}. Risks greater than 10^{-4} are considered "significant", while risks $< 10^{-7}$ are considered insignificant. Risks between 10^{-4} and 10^{-7} are within the target range; their significance will, in general, reflect site specific factors.

4 Calculations included the following carcinogenic PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. The incremental carcinogenic risk for total PAHs was calculated by multiplying the maximum concentration of each PAH other than benzo(a)pyrene by a relative potency factor to benzo(a)pyrene. The adjusted concentrations were then summed along with the concentration of benzo(a)pyrene itself and, finally, multiplied by the carcinogenic potency factor for benzo(a)pyrene. Details of this calculation process are described in the Endangerment Assessment Report for Bowers Landfill.

Department of Health over an 8-year period from 1980 to 1987. Based on this review, there is no evidence that Bowers Landfill has affected Circleville's water supply. Table 6 summarizes the data reviewed.

6.2.2 Ingestion of Surface Water

The EA identified a potential risk from ingestion of contaminated surface water. This exposure scenario was based on accidental ingestion of surface water near Bowers Landfill. Access to the landfill is not restricted, and exposure could occur if people waded in or fell into drainage ditches or the Scioto River near the landfill. The EA evaluated potential risks by comparing maximum surface water concentrations with U.S. EPA guidelines for acute or short-term exposure. Of the indicator chemicals found in surface water, only PCBs exceeded a guideline. The maximum PCB concentration of 2.6 μg/L (Table 2) was higher than the long-term ambient water quality criterion (AWQC) of 0.0126 μg/L. However, the AWQC is based on lifetime consumption of 2 liters of PCB-contaminated water per day. Thus, the AWQC is not directly applicable to the infrequent exposure and small amounts of water ingested under this exposure scenario. The EA concluded that risks from ingesting contaminated surface water were limited.

6.2.3 Ingestion of Aquatic Animals

The EA identified a potential risk from ingestion of aquatic animals from near Bowers Landfill. This exposure scenario was based on ingestion of fish and other aquatic species taken from the Scioto River. The EA compared downstream surface water concentrations (Table 2) to AWQCs for ingestion of aquatic species. Only one indicator chemical, mercury, was found above background (upstream) concentrations in the Scioto River near Bower Landfill. The maximum mercury concentration in river water (0.2 μg/L) slightly exceeded the AWQC (0.146 μg/L); the average mercury concentration was below the AWQC. This AWQC was developed by U.S. EPA to protect persons who consume 6.5 grams per day of aquatic organisms taken from mercury-contaminated water. The EA characterized risks from this scenario as limited for two reasons. First, mercury was found in only one sample from the Scioto River. Second, the mercury concentration in this sample only slightly exceeded the AWQC.

6.2.4 Ingestion of Soils

The EA identified a potential risk from ingesting contaminated soils at or near Bowers Landfill. Access to the site is not restricted, so small children could reach the site and ingest contaminated soil. The EA assumed that a 20-kg child would eat contaminated soil 10 days per

TABLE 6

SUMMARY OF WATER QUALITY SAMPLING RESULTS FOR THE CITY OF CIRCLEVILLE DEPARTMENT OF PUBLIC UTILITIES, WATER SUPPLY SYSTEM, 1980-1987 (CONCENTRATIONS OF INDICATOR CHEMICALS IN ug/L)

Location:	114 W. Franklin	#1 Well	#2 Well	#3 Well	Wells 1, 2 and 3	663 Hassle Rd.
Dates:	08/24/87	06/19/86	06/19/86	06/19/86	12/05/85	04/27/83
Compound						
Barium	160	<300	<300	<300	<300	—
Lead	1	ND	<5	<5	<5	—
Mercury	<0.2	<0.5	<0.5	<0.5	<0.5	—
Chlordane	—	—	—	—	—	ND
PCBs	—	—	—	—	—	ND
Tetrachloroethene[b]	—	—	—	—	—	<0.5
PAHs	—	—	—	—	—	ND

Notes:

Compiled from results submitted to Ohio Department of Health, 1980-1987.

a Only the results for samples that were analyzed for at least 1 indicator chemical other than tetrachloroethene are presented; see footnote b.

b 34 additional samples within this time period were analyzed for tetrachloroethene; all the results were negative.

ND Compound was analyzed for but not detected.

— Compound was not measured.

year over a 3-year period, and that 50 percent of the contaminants in the soil would be absorbed by the body. Probable case doses from this exposure were calculated based on ingesting 0.1 g/day of soil containing average contaminant levels. Worst case doses were calculated based on ingesting 1.0 g/day of soil containing maximum contaminant levels. The EA calculated doses only for those indicator chemicals found at or adjacent to the landfill at concentrations higher than background. These chemicals included barium, lead, mercury, chlordane, PCBs, and PAHs (Table 4).

The EA used the resulting doses to estimate potential risks. Noncarcinogenic risks were estimated by calculating a Hazard Index (HI), the ratio of the exposure dose to the acceptable chronic intake. Under worst case conditions, the total HI was 3.48, indicating that the estimated dose for all noncarcinogenic indicator chemicals exceeded the acceptable dose. Most of the HI was attributable to lead (HI = 3.20). However, the highest measured lead concentration at the site (179 mg/kg) was well below Centers for Disease Control (CDC) guidelines for acceptable lead values in residential soils. These guidelines suggest that lead values between 500 and 1,000 mg/kg are unacceptable.

Cancer risks were estimated by multiplying the average lifetime exposure dose by the CPF. For worst case exposure conditions, the total cancer risk for all chemicals was 3×10^{-6}. Most of this risk was attributable to ingestion of PAHs (2×10^{-6}) and PCBs (7×10^{-7}), with only a small portion due to chlordane. The probable case cancer risk was 5×10^{-9}.

6.2.5 Direct Contact with Surface Water by Aquatic Animals

The EA also identified a potential risk to aquatic species living in the Scioto River. The EA evaluated risks from this exposure scenario by comparing river water concentrations to AWQCs for protection of aquatic life. Only one of the indicator chemicals, mercury, exceeded an AWQC. The maximum mercury concentration of 0.2 μg/L (Table 2) was higher than the 4-day (chronic) AWQC for aquatic species of 0.012 μg/L. This comparison most likely overstates potential risks, since mercury was found in only one sample collected from the Scioto River.

6.3 Potential Future Risks

Even though contaminant concentrations measured during the RI are relatively low, the landfill represents a potential threat of future contaminant releases that may endanger public health, welfare, and environment. A major remedial action objective for the site is to reduce this threat of future contaminant releases in addition to reducing current risks identified in the EA. Several factors contribute to the potential threat of future releases.

First, portions of the landfill are poorly covered. The lack of adequate cover is described in inspection reports by the Ohio Department of Health (February 1967) and the Pickaway County Health Department (April 1971). These inspections were conducted shortly before and shortly after waste disposal at Bowers Landfill ended. The lack of adequate cover was confirmed by more recent measurements made in November 1988 as part of the feasibility study. These measurements showed that wastes lie less than 1 foot below the cover in some areas of the landfill.

Second, although operating records for Bowers Landfill are poor, evidence exists that hazardous substances were placed in the landfill. Responses by DuPont and PPG to a 1978 House Subcommittee on Oversight and Investigation estimated that these companies sent approximately 6,000 and 1,700 tons of waste, respectively, to Bowers Landfill from 1965 to 1968. The wastes contained a variety of organic and inorganic chemicals. More recent 1988 responses by DuPont and PPG to information requested under Section 104(e) of CERCLA confirmed the disposal of hazardous substances at landfill. However, these responses contained little additional information on the amounts and types of wastes.

Finally, semiannual flooding of the Scioto River, usually in the spring and winter, also contributes to the threat of contaminant releases. Based on flood stage data for the river and the height of the landfill, portions of the landfill are overtopped by 2-year floods. The entire landfill would be covered by a 50-year flood. Flooding, in combination with trees growing on the landfill side slopes, presents two significant concerns. First, tree roots most likely penetrate directly into waste materials because of the shallow cover depth. These root systems provide a direct pathway for flood waters and precipitation to contact wastes and increase the likelihood of future ground-water contamination. Second, as the trees on the side slopes grow larger over time, they represent a threat to the stability of the side slopes. The combination of flood conditions, saturated soil, and high winds could cause larger trees to topple over, removing portions of the side slopes and exposing the wastes underneath.

7.0 DOCUMENTATION OF SIGNIFICANT CHANGES

This Record of Decision selects Alternative 4, as described in the Proposed Plan, as the preferred remedial alternative for Bowers Landfill. U.S. EPA has reviewed and responded to all comments received during the public comment period. Comments concerned Alternative 4 and other remedial alternatives. U.S. EPA has not made any significant changes to Alternative 4 based on public comments.

Alternative 4 includes the following components: long-term ground-water monitoring; site restrictions and a perimeter fence to limit site access and use; removal of debris and vegetation from the landfill surface; placement of a low-permeability clay cap (consisting of a clay layer, topsoil layer, and vegetation) over the entire landfill surface; drainage improvements to convey rainfall and flood waters away from the landfill; and erosion and flood control measures on areas of the landfill subject to damage from flood waters.

8.0 DESCRIPTION OF ALTERNATIVES

In response to the findings of the EA, the FS identified three potential risks that should be addressed by remedial response actions at Bowers Landfill. These risks are associated with ingestion of ground water immediately downgradient of the landfill, ingestion of soil from the landfill, and future releases from the landfill.

The FS identified technologies that could reduce risks for each of these media. These technologies were assembled into media-specific remedial alternatives. The FS then screened these media-specific alternatives based on effectiveness in reducing risks, implementability, and cost. Media-specific alternatives remaining after the screening process were assembled into nine site-wide remedial alternatives for detailed evaluation. This screening process was carried out according to procedures specified by U.S. EPA in CERCLA, the NCP, and U.S. EPA guidance documents including "Interim Guidance on Superfund Selection of Remedy" (OSWER Directive No. 9355.0-19, December 24, 1986) and "Draft Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (OSWER Directive No. 9355.3-01, March 1988).

The alternatives evaluated in detail include a no action alternative and eight alternatives that rely on containment of waste, with little or no treatment, to reduce site risks. The FS looked at alternatives involving treatment as a principal element to reduce the toxicity, mobility, or volume of site wastes. However, these alternatives were screened out, based on implementability, prior to the detailed analysis. The FS did not develop any remedial alternatives for source control that would eliminate the need for long-term management, including monitoring. Treatment alternatives of this type were not considered feasible because of the large volume and diverse nature of the waste materials in Bowers Landfill.

Each of the nine remedial alternatives evaluated in detail is described briefly below. The descriptions include containment components, institutional controls, estimated time for implementation, cost, overall protection, and compliance with applicable or relevant and appropriate requirements (ARARs). Section 9.0, which describes the comparative analysis of alternatives, includes additional detail on these subjects.

8.1 Alternative 1

Alternative 1 is the no action alternative. CERCLA requires that the no action alternative be considered at every site. Under this alternative, no further action would be taken at Bowers Landfill to reduce risks or to control the sources and migration of contaminants. The no action alternative will not modify the landfill in any way. Thus, it has no associated costs, and no time would be required to implement this alternative.

Capital Cost:	$ 0
Present Worth Operation & Maintenance (O & M) Costs:	$ 0
Total Costs:	$ 0
Time to Implement:	None

8.2 Alternative 2

Alternative 2 includes the following components:

- Ground-water monitoring
- Site restrictions

Under Alternative 2, a long-term monitoring program would be implemented to monitor contaminant concentrations and migration. This program would include the installation of additional monitoring wells south of Bowers Landfill (between the landfill and the Circleville municipal wellfield) and west of the landfill (between the landfill and the Scioto River). These new wells, existing monitoring wells, and possibly residential wells near the landfill would be sampled. The monitoring program would be designed to protect the Scioto River by sampling ground water that discharges to the river. Additionally, the program would sample water from the upper and lower aquifers that may flow under the river and join regional ground-water flow. At a minimum, the program would meet the substantive requirements for ground-water monitoring under the Resource Conservation and Recovery Act (RCRA) as described in 40 CFR 264, Subpart F.

The installation of three additional ground-water monitoring well clusters is necessary to develop a ground-water monitoring program that would adequately detect potential future releases of contaminants. These well clusters would consist of three wells; a shallow well that would be located in the upper portion of the saturated alluvial aquifer, an intermediate well that would be located between the water table and the bedrock, and a deep well that would be located just above the bedrock. Two of these well clusters would be installed west of the landfill. One cluster would be installed between well location 5 and well location 6 and the other between well W-10 and the bend of the landfill (see Figure 3). The third well cluster would be installed off-site between the landfill and the Circleville municipal wellfield. The installation of well clusters in addition to these may also be considered.

The monitoring wells would be sampled on a bimonthly basis for the first year and quarterly for years 2 through 4. During the first year, samples would be analyzed for the full Target Compound List (TCL). A reduced TCL may be considered after the first year. If the levels of contaminants in ground water did not increase over this time period, the sampling schedule would be reevaluated and a reduction in the frequency of sampling may be considered. A statistical test would be developed to determine when a significant increase in the level of contaminants had occurred.

Should a significant increase in the levels of contaminants occur, it would automatically trigger a RCRA corrective action. If the levels of contaminants in ground water exceeded MCLs, where available, or health-based levels, where MCLs are not available, resampling would occur within 14 days. (Health-based levels are concentrations corresponding to a cancer risk of 10^{-6} for carcinogenic contaminants and a hazard index (HI) greater than 1 for noncarcinogenic contaminants.) If the resampling verified that there had been a significant increase in the levels of contaminants, a corrective action program would be implemented. Corrective action may include such measures as the establishment of alternate concentration limits (ACLs), the collection and treatment of ground water, or the removal of the source of contamination.

The surface water in the drainage ditch to the east of the landfill would be sampled on a quarterly basis as part of the monitoring program. Monitoring would verify that discharges from the ditch are in compliance with Ohio Water Quality Standards, as described in the Ohio Administrative Code (OAC) 3745-01. A corrective action program would be implemented if contaminant levels in the ditch exceeded these standards.

Efforts will be made to procure deed restrictions prohibiting ground-water extraction in the field west of the landfill and restricting disturbance of the landfill surface. The viability of continued farming immediately west of the landfill would be evaluated, and, if shown to be necessary, efforts would be made to prohibit such farming by imposition of deed restrictions. A 6-foot fence would be placed around the landfill, the drainage ditch to the east, and the field to the west to limit site access.

Alternative 2 relies entirely on institutional controls and monitoring to reduce risk and does not include any containment or treatment components. Restricting ground-water use immediately downgradient of the site should be effective in eliminating risks from drinking this ground water. However, while fencing is identified as a means for limiting exposure, contaminated soils would remain uncovered. Exposure could still occur through dispersal of soil by erosion and by direct contact if persons enter the site despite the fence. Potential future risks, as described in Section 6.3, would not be reduced. Further, Alternative 2 does not meet State of Ohio closure requirements for solid waste landfills, which has been identified as an ARAR.

The costs of Alternative 2 and the estimated time for implementation are as follows:

Capital Cost:	$ 173,700
Present Worth O & M Costs:	$ 295,100
Total Costs:	$ 468,800
Time to Implement:	1 Month

8.3 Alternative 3

Alternative 3 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Local repairs to existing landfill cover
- Erosion control and drainage improvements

Alternative 3 incorporates ground-water monitoring and site restrictions already described under Alternative 2. The additional components of this remedial alternative are discussed below.

The landfill area and its immediate vicinity would be cleared of surface debris. Nonhazardous debris would be disposed of at a nearby sanitary landfill, and any waste items determined to be hazardous would be disposed of at a suitable hazardous waste landfill.

After surface debris has been removed, areas showing signs of erosion would be identified. These areas would be cleared of vegetation and repaired with natural clay soil to be uniform with the surrounding surface. Drainage patterns on the landfill would be surveyed, and areas showing erosion would be repaired with fill. Areas prone to ponding would be regraded to provide a uniformly sloping surface that would drain water off the landfill. The existing vegetation cover of trees on the landfill would be maintained. As part of the maintenance program, the cover would be inspected on a regular basis for structural integrity and vegetative growth.

The drainage ditch east of the landfill would be improved to allow water to drain from the field north of the landfill through this ditch. The pipe that runs under the southern end of the landfill from this ditch would be replaced by a 36-inch-diameter corrugated metal pipe.

Erosion protection would be provided on those landfill areas prone to erosion due to swift-flowing water from the river. This protection would include armor stone (riprap) in areas that abut the river. Stone would also be placed on the north-facing slope of the western edge of the landfill and at the southern edge of the landfill to dissipate the energy of river flow.

Alternative 3 addresses some containment aspects for contaminated soils by providing limited repairs to the existing landfill cover. However, since repairs would be made on a visual basis, this alternative cannot ensure that all areas of contaminated soil would be covered. The landfill would remain largely unchanged and susceptible to erosion and infiltration of precipitation and surface water during flood events. Trees would not be removed from the landfill surface, further increasing the potential for infiltration. As noted for Alternative 2, this alternative does not address Ohio closure requirements for solid waste landfills.

The costs of Alternative 3 and the estimated time to implement this alternative are:

Capital Cost:	$ 1,427,300
Present Worth O & M Costs:	$ 741,000
Total Costs:	$ 2,168,300
Time to Implement:	3 Months

8.4 Alternative 4

Alternative 4 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Natural clay cover over landfill
- Erosion control and drainage improvements

Alternative 4 contains the same site restrictions as described for Alternative 2. In addition, the ground-water monitoring program would be identical to the program described under Alternative 2. Erosion and drainage control improvements would be similar to those described for Alternative 3. However, instead of limited repairs to the landfill cover, Alternative 4 includes a clay cover over the entire landfill surface. All trees and other vegetation would be cut down to the surface, and steps would be taken to prevent their growth through the new cover. Precautions would be taken to minimize exposure of buried waste during removal of vegetation.

The new cover would consist of a well-compacted, low-permeability clay cover at least 24 inches thick. A top soil layer at least 24 inches thick would be placed over the clay cover. This top soil layer would be planted with grasses or other shallow-rooted plant species. The cover would exceed Ohio closure requirements for solid waste landfills, which call for only a well-compacted 24-inch cover of suitable material. The clay layer would have a maximum permeability of 10^{-7} cm/sec and would limit infiltration to less than 10 percent of precipitation.

Prior to cover installation, a detailed geotechnical investigation would be conducted to measure the properties of the soil and clay used to construct the cover. The purpose of this investigation would be to determine the stability of these materials under flood conditions. The cover would then be constructed with side slopes flat enough to protect the landfill from damage due to flooding. Construction would be done in such a manner as to minimize potential harm to the floodplain, as required by 40 CFR 6, Appendix A, Statement of Procedures on Floodplain Management and Wetlands Protection. In addition, the cap would be constructed, operated, and maintained to prevent washout of any hazardous wastes by a 100-year flood, as required by RCRA General Facility Standards in 40 CFR 264.18. These regulations have been identified as a location-specific ARARs.

The cap and fence would be inspected on a quarterly basis and repairs of any significant damage would begin within 30 days. The landfill would also be inspected for leachate and methane gas production on a quarterly basis. If leachate production occurred that could potentially adversely affect public health or the environment, a leachate collection system would be installed and the leachate would be collected and treated. If methane gas production occurred that could potentially adversely affect public health or the environment, a gas venting system would be installed.

The drainage ditch adjacent to the east side of the landfill would be improved by removing sediments as necessary. The pipe that runs under the landfill from the southern end of the ditch would be replaced by a 36-inch-diameter corrugated metal pipe. These improvements would allow water to drain from the field north of the landfill through the ditch and into the Scioto River. During the design of this alternative, the feasibility of removing contaminated sediments from the drainage ditch would be evaluated. These sediments could be dewatered as necessary and placed on the landfill surface prior to installing the clay cap. The drainage ditch, which is contiguous with the eastern side slope of the landfill, can be considered part of the landfill. Therefore, movement of sediments from the ditch to the landfill would consolidate hazardous wastes within a single disposal unit. This would not constitute "land disposal" under RCRA Subtitle C, so RCRA land disposal restrictions in 40 CFR 268 would not be ARARs. Sediment removal, in conjunction with capping, would reduce the possibility of contaminated surface water discharges from the ditch to the Scioto River.

Alternative 4 uses site restrictions to reduce risks from ingestion of ground water. Soil ingestion risks would be greatly reduced because the entire landfill surface, where highest soil contamination levels were found, would be covered. Long-term risks would be reduced by the application of a cover that reduces infiltration through the landfill.

The costs and time to implement Alternative 4 are listed below:

Capital Cost:	$ 3,173,000
Present Worth O & M Costs:	$ 1,094,500
Total Costs:	$ 4,267,500
Time to Implement:	10 Months

8.5 Alternative 5

Alternative 5 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Natural clay cover over landfill
- Erosion control and drainage improvements
- Leachate collection system
- Gas venting system

Alternative 5 is identical to Alternative 4, except that the landfill cover would incorporate gas venting and leachate collection systems. The gas venting system would consist of a network of perforated pipe, approximately 6 inches in diameter, laid at 100-foot intervals in a 12-inch layer of gravel over the landfill surface. The gravel layer would have a geotextile fabric placed over the top to prevent spaces in the gravel layer from clogging. A 24-inch clay cover would be placed over the gravel layer, followed by a 24-inch soil and vegetation cover. Gas vents would connect to the perforated pipe and exit vertically through the clay and soil covers. Gases containing high concentrations of VOCs could be passed through a vapor phase carbon adsorption system to remove these contaminants.

The leachate collection system, located at the toe of the landfill, would consist of a perforated PVC pipe in a trench filled with granular drainage material. The pipe would catch and direct leachate to a collection point. From there, the leachate would be pumped to a temporary holding tank, treated, and discharged.

Alternative 5 would provide slightly greater protection than Alternative 4 because of the added leachate and gas collection systems. It would also comply with ARARs and would exceed Ohio solid waste landfill closure requirements.

The costs and time to implement Alternative 5 are as follows:

Capital Costs:	$ 4,341,200
Present Worth O & M Costs:	$ 2,374,600
Total Costs:	$ 6,715,800
Time to Implement:	10 Months

8.6 Alternative 6

Alternative 6 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Natural clay cover over landfill
- Drainage improvements
- Leachate collection system
- Gas venting system
- Flood protection dike

Alternative 6 is identical to Alternative 5, except that additional flood protection would be provided by constructing a flood protection dike. The dike would extend around the west and north sides of the landfill. A concrete wall would be constructed at the south and northwest corners of the landfill, where there is insufficient space for a dike between the landfill and the river. The core of the flood dike would be constructed of an impervious clay material, and the side slopes would be constructed from clean soil. The sides of the dike along the river would be protected against surface water erosion by concrete riprap or rock fill. Stormwater within the flood control dike and the ditch east of the landfill would be collected through a gravity drainage system that discharges water to the river through check valves.

Alternative 6 addresses all site risks, including the potential risk of future releases from the landfill. The flood protection dike would provide additional protection to the landfill, once the new clay cover is installed. Alternative 6 would exceed Ohio solid waste closure requirements and would comply with ARARs for construction in floodplains.

The costs and implementation time for Alternative 6 are as follows:

Capital Costs:	$ 9,094,300
Present Worth O & M Costs:	$ 3,060,000
Total Costs:	$ 12,154,300
Time to Implement:	18 Months

8.7 Alternative 7

Alternative 7 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Synthetic membrane cap over landfill
- Drainage improvements
- Leachate collection system
- Gas venting system
- Flood protection dike

Alternative 7 is similar to Alternative 6 except that a synthetic membrane cap would be placed over the landfill rather than a clay cap. The design of the landfill cap would be similar to the design specified in the Resource Conservation and Recovery Act (RCRA). A permeable geotextile fabric would be placed over the gas collection and venting system, followed by a 2-foot-thick layer of compacted clay with a permeability of 10^{-7} cm/sec. A 20-mil (minimum) synthetic membrane would be placed directly on the compacted clay layer. Finally, a 12-inch drainage layer with a hydraulic conductivity of at least 10^{-3} cm/sec would be placed over the synthetic liner, followed by a 24-inch-thick vegetated soil cover. The FS estimates that this cap would reduce infiltration through the landfill to less than 1 percent of precipitation. In addition, the flood protection dike would minimize the chance of flood waters contacting the landfill surface.

Alternative 7 addresses all site risks, including the potential risk of future releases from the landfill. This alternative would exceed Ohio solid waste closure requirements and would comply with ARARs for construction in floodplains.

The estimated costs and implementation time for Alternative 7 are:

Capital Costs:	$ 10,367,400
Present Worth O & M Costs:	$ 3,449,300
Total Costs:	$ 13,816,700
Time to Implement:	18 Months

8.8 Alternative 8

Alternative 8 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Synthetic membrane cap over landfill
- Erosion control and drainage improvements
- Leachate collection system
- Gas venting system

Alternative 8 is similar to Alternative 7, without the flood protection dike. Instead of the dike, this alternative provides erosion control at the ends of the landfill using riprap as described under Alternative 3. All other components of this alternative have been described previously and are not repeated here.

The synthetic membrane cap over the landfill would cover most contaminated soils and would reduce long-term risks by reducing infiltration through the landfill cover to less than 1 percent of precipitation. This alternative would exceed Ohio solid waste closure requirements and would comply with ARARs for construction in floodplains.

The estimated costs and implementation time for Alternative 8 are:

Capital Costs:	$ 6,228,500
Present Worth O & M Costs:	$ 2,328,400
Total Costs:	$ 8,556,900
Time to Implement:	10 Months

8.9 Alternative 9

Alternative 9 includes the following components:

- Ground-water monitoring
- Site restrictions
- Management of surface debris
- Natural clay cover over top of landfill
- Improvements to landfill side slopes
- Erosion control and drainage improvements

Alternative 9 is similar to Alternative 3, except that a natural clay cover would be placed on the top of the landfill. This clay cover would be similar to the cover installed over the entire landfill surface in Alternative 4. Under Alternative 9, side slopes would not be covered, but would be repaired as necessary. These repairs would be made to increase the depth of the cover and provide continuously sloping surfaces. The tree cover on the landfill side slopes would be thinned out, but most trees would be left in place.

Drainage patterns would be surveyed, and areas such as erosion rifts and terraces would be filled and regraded to match adjacent contours. The fill applied to the side slopes would be compacted. Where side slopes are steep, additional stabilization would be accomplished by placing riprap or by supporting the slopes using sheet piling or soil cement.

Drainage control berms would be constructed at the top of the landfill to collect stormwater runoff. The water collected by the berms would be directed to the base of the side slopes by drainage chutes. The collection and drainage system would help reduce infiltration through the side slopes by limiting the area contacted by runoff from the top of the landfill.

Alternative 9 addresses some containment aspects for contaminated soils by covering the top of the landfill and providing limited repairs to the side slopes. However, this alternative cannot ensure that all areas of contaminated soil would be covered. The landfill side slopes would remain largely unchanged and susceptible to erosion and infiltration of precipitation and surface water during flood events. Trees would not be removed from the landfill surface, further increasing the potential for infiltration. This alternative would not meet Ohio closure requirements for solid waste landfills because of the incomplete repairs to side slopes.

The costs of Alternative 9 and the estimated time to implement this alternative are:

Capital Costs:	$ 2,483,500
Present Worth O & M Costs:	$ 955,900
Total Costs:	$ 3,439,400
Time to Implement:	8 Months

9.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

U.S. EPA used the following nine criteria to evaluate each of the alternatives identified in the FS report. The remedial alternative selected for the site must represent the best balance among the evaluation criteria.

1. Overall Protection of Human Health and the Environment addresses whether a remedy adequately protects human health and the environment and whether risks are properly eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with Applicable or Relevant and Appropriate Requirements addresses whether a remedy meets all state and federal laws and requirements that apply to site conditions and cleanup options.

3. Long-Term Effectiveness and Permanence refers to the ability of a remedy to reliably protect human health and the environment over time once cleanup goals have been met.

4. Reduction of Toxicity, Mobility, or Volume are three principal measures of the overall performance of an alternative. The 1986 Superfund Amendments and Reauthorization Act (SARA) emphasizes that, whenever possible, U.S. EPA should select a remedy that will permanently reduce the level of toxicity of the contaminants at the site, the spread of contaminants away from the site, and the volume, or amount, of contaminants at the site.

5. Short-Term Effectiveness refers to the likelihood of any adverse impacts to human health or the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

6. Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the remedy.

7. Cost includes capital and operation and maintenance costs of implementing a remedy.

8. State Acceptance indicates whether, based on its review of the RI, EA, FS, and Proposed Plan, the State of Ohio (OEPA) concurs with, opposes, or has no comment on the alternative U.S. EPA is proposing as the remedy for the site.

9. Community Acceptance indicates whether the public concurs with the remedy presented in U.S. EPA's proposed plan.

After evaluating all the remedial alternatives developed in the FS, using the nine criteria just described, U.S. EPA has selected Alternative 4 to address contamination at the Bowers Landfill Superfund site. The rationale for this selection is provided below.

9.1 Overall Protection of Human Health and the Environment

Alternative 4 would protect both human health and the environment. This alternative would reduce potential risks from ingestion of contaminated soil by installing a fence around the site and by covering the most highly contaminated soils with 4 feet of clay and soil. The FS estimates that probable case risks for soil ingestion would be reduced to zero. Some residual risk would remain due contaminated soils in the field west of the landfill. To estimate exposure to this remaining contamination, the FS assumed that (1) 50-kg teenagers would scale the fence surrounding the site 10 times per year over a 5-year period, (2) these teenagers would ingest 200 mg of contaminated soil per visit, and (3) 50 percent of the contaminants in ingested soil would be absorbed by the body. Based on these assumptions and the maximum soil contaminant concentrations in the areas not affected by the cover, the HI for noncarcinogenic risks would be reduced from 3.48 to 0.24. The carcinogenic risk, based on average lifetime exposure, would be reduced from 3×10^{-6} to 4×10^{-8}. Risk reductions for Alternatives 5 through 8, which cover the same areas of soil contamination, would be identical. In contrast, Alternatives 2, 3, and 9 do not cover the entire landfill surface and would provide a smaller risk reduction. The FS estimates that these alternatives would result in an HI of 0.28 for noncarcinogenic effects and a carcinogenic risk of 5×10^{-7}.

Alternative 4 would reduce risks from ingestion of ground water by placing access restrictions on the area west of the landfill. These restrictions would prevent the use of this area as a future ground-water source. In addition, the clay and soil cap would reduce infiltration to less than 10 percent of precipitation, reducing the likelihood of future ground-water contamination. Alternatives 5 and 6, which have a similar cap, would also reduce infiltration to less than 10 percent. Alternatives 7 and 8, which include a synthetic membrane cap, would provide much greater reductions in infiltration.

Ground-water users farther from Bowers Landfill would be protected by the monitoring program included as part of Alternative 4. This program would include installing and sampling additional wells south and west of the landfill. Expansion of the monitoring network to the south would detect any future migration of ground-water contamination toward the City of Circleville's wellfield, 1½ miles south of the landfill. Alternative 4 would include a corrective action program that would allow prompt response to any significant increases in ground-water contamination that might occur in the future.

Overall, Alternative 4 would be more protective of human health and the environment than Alternatives 1, 2, 3, and 9. These alternatives include either no modifications or limited modifications to the existing landfill surface.

Alternative 4 would be somewhat less protective than Alternatives 5, 6, 7, and 8, which include more extensive remediation. For example, Alternative 7, the most protective alternative, also includes a synthetic membrane cap, a flood protection dike, a leachate collection system, and a gas venting system. The overall effect of these additional measures would not increase protection with respect to ingesting contaminated soils or ground water. The flood protection dike included in Alternatives 6 and 7 may prolong the effective life of the landfill cap due to less erosion from surface water. However, the cap installed under Alternative 4 would be designed and constructed to resist flood damage or washout of wastes by a 100-year flood and would have a minimum 30-year lifetime. The multilayer cap included in Alternatives 7 and 8 might provide greater reductions in infiltration, thus providing greater protection against the generation of contaminated leachate and future ground-water contamination. However, there is little evidence of a leachate problem at Bowers Landfill, and current levels of ground-water contamination are low. Therefore, the low-permeability clay cap constructed under Alternative 4 would provide adequate protection of ground water.

9.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 4 would comply with applicable or relevant and appropriate state and federal requirements (ARARs). These requirements include action-specific ARARs related to closure of Bowers Landfill, location-specific requirements related to the location of the landfill within the 100-year floodplain of the Scioto River, and chemical-specific ARARs for contaminants identified in environmental media at the landfill.

Alternative 4 is primarily a closure plan for Bowers Landfill, and the major action-specific ARARs to be considered are those related to landfill closure. Waste disposal at Bowers Landfill ended around 1968, before the effective date of RCRA. Thus, RCRA Subtitle C requirements for the treatment, storage, and disposal of hazardous wastes are not applicable to remedial actions at the landfill. Additionally, the wastes in Bowers Landfill contain large volumes of low-toxicity material, widely dispersed over a large area that bears little resemblance to the discrete units regulated under RCRA Subtitle C. Nevertheless, portions of RCRA Subtitle C requirements can be considered relevant and appropriate.

The preamble to proposed revisions to the National Contingency Plan (53 Federal Register, December 21, 1988) describes several options for closure of Superfund sites, based on RCRA requirements. One option is "closure with wastes in place." This option requires a final cover over the contaminated materials and post-closure care, including maintenance of the cover, ground-water monitoring, and corrective action if ground-water protection standards are exceeded in the future. A second option is "alternate land disposal closure." Under this option, landfill cover requirements are relaxed because (1) the cover will reduce risks due to direct contact with wastes and (2) the wastes appear to pose a limited threat to ground water.

Alternative 4 falls between these two options, but closer to the first option. The clay cap installed as part of this alternative would have a permeability of 10^{-7} or less. This cap would meet the requirements for the clay layer at the bottom of a hazardous waste landfill, as described in 40 CFR 264.301. Because current ground-water contamination levels at Bowers Landfill suggest a limited threat to ground water, a synthetic membrane layer is not considered a necessary component of the cap. On the other hand, Alternative 4 would exceed the relaxed cover requirements for "alternate land disposal closure." These requirements are more similar to State of Ohio closure regulations for solid waste landfills, which call for a "well compacted layer of final cover material . . . to a depth of at least two feet." Alternative 4 would substantially exceed this requirement by providing a 4-foot-thick cover, including a 2-foot layer of low-permeability clay.

Alternative 4 would also comply with location-specific ARARs. Because Bowers Landfill is located within the 100-year floodplain of the Scioto River, construction within the floodplain is unavoidable. However, Alternative 4 would be constructed in a manner that would minimize potential harm to the floodplain, as specified by floodplain management requirements in 40 CFR 6. In addition, the cap would be constructed, operated, and maintained to prevent washout of any hazardous wastes by a 100-year flood, as required by RCRA General Facility Standards in 40 CFR 264.18.

Alternative 4 would attain chemical-specific ARARs for ground water by reducing infiltration of precipitation and floodwaters through the landfill waste. Ground-water results from the RI showed that benzene slightly exceeded the MCL of 5 $\mu g/L$ in one sample from well P-6B. Levels in other samples from this well were below the MCL, and benzene was not detected in any of the remaining 12 downgradient wells. Barium also exceeded the MCL in three samples collected from a single well, well P-5B. However, the average barium concentration was well below the MCL. The ground-water monitoring program implemented under Alternative 4 would require regular and systematic sampling and would meet the substantive requirements for ground-water monitoring under RCRA in 40 CFR 264, Subpart F. The monitoring program would include provisions for corrective action should contaminant levels significantly increase in the future.

Additionally, the monitoring program proposed for Alternative 4 would include collecting surface water samples from the ditch east of Bowers Landfill. Surface water monitoring would verify that discharges from the ditch are complying with Ohio Water Quality Standards as described in OAC 3745-01.

Alternatives 5 and 6 would comply with ARARs to the same extent as Alternative 4. Alternatives 7 and 8, by including a synthetic membrane layer in addition to the low-permeability clay layer, would come closer to meeting RCRA requirements for closure with hazardous wastes in place.

Alternatives 1, 2, 3, and 9 would leave some or all of the current soil and vegetation cover intact. These alternatives would not comply with relevant and appropriate portions of RCRA closure regulations or with Ohio closure standards for solid waste landfills. Further, these alternatives would not meet location-specific ARARs because they would not be constructed, operated, and maintained to prevent washout of hazardous wastes by a 100-year flood. Also, Alternatives 1, 2, 3, and 9 would not significantly reduce infiltration of precipitation and flood waters through the landfill, and may not result in attainment of MCLs in ground water.

9.3 Long-Term Effectiveness and Permanence

Because of the large amount of material within Bowers Landfill, the small known percentage of hazardous waste, and the limited risks identified in the EA report, it was not feasible to develop a permanent remedy for Bowers Landfill. However, the low-permeability clay cap specified by Alternative 4 would be designed for a minimum 30-year lifetime. The long-term effectiveness of Alternative 4 would be ensured by ground-water monitoring and maintenance of the clay cap. Monitoring wells downgradient of the landfill would be sampled on a regular basis to determine if contaminant concentrations in ground water are increasing significantly over time. The monitoring program would also include a corrective action component, requiring further remedial action if a significant increase in ground-water contamination is detected. The maintenance program for Alternative 4 would include regularly mowing the vegetation on the cap; inspecting the surface for cracks, settlement, ponding, and erosion; completing appropriate repairs to the cap; and repairing the fence as necessary. In addition to regularly scheduled inspections, additional inspections would be made after floods.

Similar monitoring, inspection, and maintenance would be needed to maintain the long-term effectiveness of Alternatives 5, 6, 7, and 8. These alternatives include additional components, such as a synthetic membrane cap or a flood protection dike, that may increase long-term effectiveness. However, the additional components would not greatly increase long-term effectiveness compared to Alternative 4. Current landfill conditions, 20 years after disposal ceased, indicate that Alternative 4 would be sufficiently protective in the long-term. Thus, the slightly higher long-term effectiveness of Alternatives 5, 6, 7, and 8 does not justify the substantially higher costs of these alternatives.

In contrast, Alternatives 1, 2, 3, and 9 would be much less effective in the long term. Alternatives 1 and 2 do not include any repairs to the existing landfill cover. Alternatives 3 and 9 make limited repairs, but would not cover the entire landfill surface. Alternatives 1, 2, 3, and 9 would also leave trees on the landfill side slopes. These alternatives would allow greater infiltration of precipitation and flood waters than Alternatives 4 through 8 because of the incomplete cover and because tree roots probably penetrate into waste materials below the cover. These alternatives would also have a greater potential for long-term failure of the landfill side slopes. Over time, the combination of saturated soil conditions during flooding and high winds could result in complete uprooting of trees, exposing underlying waste materials.

9.4 Reduction of Toxicity, Mobility, or Volume

None of the remedial alternatives evaluated in the FS report involves treating source materials from Bowers Landfill. Thus, none of the alternatives would reduce the toxicity or volume of hazardous constituents within the waste. Treatment alternatives for the source materials were considered but were not evaluated in detail for several reasons. First, most of the estimated 130,000 cubic yards of waste material in Bowers Landfill consists of general refuse and municipal solid waste. Although the exact amount of hazardous waste placed in the landfill is not known, it is probably a small percentage of the total waste volume. The large volume and variable composition of wastes makes treatment impractical. Second, no operating records exist for the landfill. Thus, it is not feasible to identify locations where hazardous wastes might have been placed. Third, the relatively low levels of contamination found during the RI would not be effectively reduced by treatment.

Alternatives 5, 6, 7, and 8 include provisions for installing a leachate collection and treatment system, which is a treatment alternative. This system may reduce the volume and mobility of leachate if leachate contains hazardous constituents. However, ground-water analyses from the RI did not indicate significantly elevated contaminant levels in the upper aquifer, which would be the first target of a leachate plume. Additionally, the low-permeability clay cap installed under Alternative 4 should greatly reduce future leachate generation by reducing infiltration through the landfill. For these reasons, the installation of a leachate collection system was considered but then rejected.

Similarly, Alternatives 5, 6, 7, and 8 include a collection system for gases generated by the landfill. Collected gases could be treated, if necessary. However, Alternative 4 does not include gas collection and treatment for the following reasons. First, air monitoring results from the RI showed that air concentrations of volatile organic compounds (VOCs) at Bowers Landfill are similar to off-site background concentrations. Second, the landfill has a low potential to emit VOCs to air because of the low concentrations of VOCs in soils, sediments, and surface water on or adjacent to the landfill. Finally, because of the age of the landfill, most of the potential gas generation may already have taken place. These gases would have readily escaped through the highly permeable soil that now covers the landfill.

Alternative 4 would reduce the mobility of waste materials within the landfill. The FS report estimates that the low-permeability clay cap included in this alternative will reduce direct infiltration into the landfill surface by over 90 percent. This is much more effective than the current soil and vegetation cover. Reducing the amount of water that contacts waste materials within the landfill should reduce the mobility of these materials. Alternatives 5 and 6, which also include a clay cap, would provide similar reductions in infiltration. Alternatives 7 and 8, which include a synthetic plastic liner and a clay cap, would further reduce infiltration (estimated in the FS report as greater than 99 percent). However, these much greater reductions do not appear warranted by current levels of ground-water contamination at Bowers Landfill.

In contrast, Alternatives 1 and 2 (no repairs to the existing cover), Alternative 3 (limited repairs to the cover), and Alternative 9 (application of a partial clay cover) would provide either no reduction or less reduction in infiltration. Each of these alternatives would leave trees on the landfill side slopes. Root systems of these trees would provide a direct path between flood waters or precipitation and the underlying waste materials.

9.5 Short-Term Effectiveness

The FS report estimates that Alternative 4 could be constructed within 10 months; the alternative would effectively protect human health and the environment immediately upon completion. This construction period is longer than the 1 month required for Alternative 3, which includes only limited repairs to the existing landfill cover. Alternatives 5, 8, and 9 would require construction periods similar to that for Alternative 4. However, Alternatives 6 and 7 would require approximately 18 months to complete due to the more extensive construction activities.

Alternative 4 and the other alternatives could be constructed without significant adverse impacts on the environment and people living near Bowers Landfill. However, all the alternatives, with the exception of those requiring no construction, would present general safety-related risks to construction workers. In addition, earth moving activities could generate dust from the landfill surface that could potentially affect workers and surrounding populations. However, these effects could be minimized by using standard dust suppression methods, such as watering. Additionally, air monitoring would be conducted to measure contaminants released during construction. Construction practices would be modified as necessary to prevent unacceptable releases.

A major impact of Alternative 4 on the surrounding community would be increased truck traffic near the site. The FS report estimates that approximately 8,000 truckloads of material would enter and leave the site during construction. Over a 10-month period, this figure corresponds to an average of 40 trucks per work day. This could inconvenience local residents, adversely affect local roads, and present a slightly greater risk of traffic accidents near the site. Increased truck traffic is also a component of other construction alternatives. The estimated total number of trucks varies from 1,225 for Alternative 3 to 12,000 for Alternatives 6 and 7.

9.6 Implementability

Alternative 4, and all other alternatives evaluated in the FS report, could be implemented using standard earth moving equipment and construction techniques. However, the primary problem of flooding could affect the implementation of all alternatives except Alternative 1 (no action). Construction activities would have to be scheduled around flood events, since the area adjacent to the landfill is inundated approximately 30 days per year. Construction of Alternatives 4 through 9 is estimated to require 8 to 18 months to complete. Thus, remedial action would have to be segmented into work areas. Work on one area of the landfill would be completed before construction of the next area began. This method would minimize the area of the landfill exposed to any particular flood event.

A second implementation problem, common to Alternatives 3 through 9, is the availability of low-permeability clay near the landfill. These alternatives would require substantial amounts (up to 50,000 cubic yards) of clay for construction. The FS report assumes that a suitable clay source can be found locally. However, if a local source cannot be found, increased transport of clay would be required, resulting in increased costs.

A third implementation problem affects Alternatives 3 through 9. These alternatives would require removing existing vegetation from all or part of the landfill. This activity, especially the removal of large trees, could expose underlying waste materials. Precautions would be taken to minimize this possibility.

None of the alternatives appears to present any major administrative problems that would affect implementation. However, the flood protection dike included in Alternatives 6 and 7 would involve substantial construction in the Scioto River floodplain. Construction of the dike would remove approximately 80 acres of land from the 100-year floodplain, since the dike would prevent floodwaters from covering this area. This would increase the height of floodwaters upstream and downstream of the landfill and may cause additional areas to flood. Because of this potential problem, Alternatives 6 and 7 may be administratively more difficult to implement.

9.7 Cost

The estimated total present worth cost for Alternative 4 is approximately $4.3 million. This estimate includes capital costs of approximately $3.2 million for fencing, drainage improvements, erosion and flood control measures, and installation of the landfill cap. Annual operation and maintenance (O&M) costs for this alternative are estimated at approximately $116,000 and include expenses related to ground-water monitoring and general maintenance of the fence, drainage system, erosion and flood control measures, and landfill cap. The present worth of annual O&M costs (over a 30-year period at a 10 percent interest rate) is approximately $1.1 million.

Alternative 4 would be more expensive to implement than Alternatives 1, 2, 3, and 9. However, these alternatives would not provide the degree of overall protection offered by Alternative 4. Alternatives 5, 6, 7, and 8 would provide somewhat greater protection than Alternative 4, but at a much greater cost. Estimated total present worth costs for these alternatives range from $6.7 million to $13.8 million. Increased costs are associated with more sophisticated technologies such as a leachate collection system and gas venting system (Alternatives 5 through 8), a flood protection dike (Alternatives 6 and 7), and a landfill cap with a synthetic liner (Alternatives 7 and 8).

The total cost of Alternative 5 is approximately 50 percent higher than Alternative 4 ($6.7 million compared to $4.3 million), while Alternatives 6 through 8 involve much greater costs ($12.2 million, $13.8 million, and $8.6 million respectively). Although these alternatives may offer increased long-term protection, the relative cost increase outweighs the expected benefits. For example, the installation of a gas venting system does not appear necessary. Several factors indicate that gas generation is not a problem at Bowers Landfill. Such factors include the age of the landfill, the porous nature of the current landfill cover, the frequent flooding of the landfill, and the lack of elevated VOC and gas levels during the RI. Likewise, the installation of a leachate collection system does not appear justified because of little evidence that leachate is significantly affecting the upper aquifer. The low-permeability clay cap installed under Alternative 4 would further reduce leachate generation. The installation of a RCRA cap and flood protection dike are likewise not justified. A RCRA cap would decrease infiltration to less than 1 percent of precipitation. However, at a much lower cost, the clay cap included in Alternative 4 would decrease infiltration to less than 10 percent of precipitation. With respect to the flood protection dike, the landfill's north side appears to be stable under current conditions. It should be possible to install a new landfill cover that will resist flood damage without the added expense of a flood protection dike.

U.S. EPA has made minor revisions to remedial alternatives based on comments received during the public comment period. As a result, costs may be slightly higher than the estimates presented in this section.

9.8 State Acceptance

The State of Ohio has concurred with U.S. EPA's selection of Alternative 4 as the preferred remedial alternative for Bowers Landfill. A letter of concurrence is attached to this Record of Decision.

9.9 Community Acceptance

U.S. EPA's preferred remedial alternative for Bowers Landfill was presented at the start of the public comment period through distribution of a fact sheet, publication of display advertisements in the Cirvleville, Ohio, Herald, and placement of the proposed plan in the site information repositories. A formal public meeting to discuss the proposed plan was held in Circleville on February 28, 1989. Comments received indicate that many residents are concerned about U.S. EPA's preferred alternative.

These comments focus on three general areas. First, several residents commented that U.S. EPA appears to be closing Bowers Landfill as a solid waste landfill, with no consideration of the hazardous wastes that were disposed of at the site. These residents prefer Alternatives 7 and 8, which include additional protective measures such as a synthetic liner (in addition to the clay cap) and a flood protection dike. U.S. EPA has pointed out in this Decision Summary that relevant and appropriate portions of hazardous waste regulations in RCRA Subtitle C have been adequately considered in the design and selection of Alternative 4. This issue is discussed further in the Responsiveness Summary.

Second, several residents expressed concern about U.S. EPA's proposed ground-water monitoring plan for Bowers Landfill. These concerns are directly related to protection of public drinking water supplies -- specifically, the City of Circleville's wellfield located 1½ miles south of the landfill. To address these concerns, the ground-water monitoring program will include installing and sampling additional monitoring wells south of Bowers Landfill. Further, U.S. EPA will require that corrective action program options be developed as part of the monitoring program. This will allow prompt response if ground-water contaminant levels exceed levels of concern at any compliance point in the monitoring system.

Finally, several residents expressed concern that U.S. EPA's preferred alternative represents a conceptual design, specific elements of which will be determined later with limited input from local residents. To address this concern, U.S. EPA will consider extending the Bowers Landfill Information Committee (see Section 3.0) through the remedial design/remedial action phase of this project.

10.0 THE SELECTED REMEDY

After evaluating all the feasible alternatives, U.S. EPA is selecting a remedy that consists of five components: (1) ground-water monitoring; (2) site access restrictions; (3) management of surface debris; (4) erosion control and drainage improvements; and (5) a natural clay cover over the landfill. These five components are described in detail below.

10.1 Ground-Water Monitoring

Under Alternative 4, a long-term program will be implemented to monitor contaminant concentrations and migration. This program will include installing additional monitoring wells south of Bowers Landfill (between the landfill and the Circleville municipal wellfield) and west of the landfill (between the landfill and the Scioto River). These new wells, existing monitoring wells, and possibly residential wells near the landfill will be sampled regularly. At a minimum, the program will meet the substantive requirements for ground-water monitoring under RCRA as described in 40 CFR 264, Subpart F.

The installation of three additional ground-water monitoring well clusters is necessary to develop a ground-water monitoring program that will adequately detect potential future releases of contaminants. These well clusters will consist of three wells; a shallow well that will be located in the upper portion of the saturated alluvial aquifer, an intermediate well that will be located between the water table and the bedrock, and a deep well that will be located just above the bedrock. Two of these well clusters will be installed west of the landfill. One cluster will be installed between well location 5 and well location 6 and the other between well W-10 and the bend of the landfill (see Figure 3). The third well cluster will be installed off-site between the landfill and the Circleville municipal wellfield. The installation of well clusters in addition to these may also be considered.

The monitoring wells will be sampled on a bimonthly basis for the first year and quarterly for years 2 through 4. During the first year, samples will be analyzed for the full Target Compound List (TCL). A reduced TCL may be considered after the first year. If the levels of contaminants in ground water do not increase over this time period, the sampling schedule will be reevaluated and a reduction in the frequency of sampling may be considered. A statistical test will be developed to determine when a significant increase in the level of contaminants has occurred.

Should a significant increase in the levels of contaminants occur, it will automatically trigger a RCRA corrective action. If the levels of contaminants in ground water exceed MCLs, where available, or health-based levels, where MCLs are not available, resampling will occur within 14 days. (Health-based levels are concentrations corresponding to a cancer risk of 10^{-6} for carcinogenic contaminants and a hazard index (HI) greater than 1 for noncarcinogenic contaminants.) If the resampling verifies that there has been a significant increase in contaminant levels, a corrective action program will be implemented. Corrective action may include such measures as establishing alternate concentration limits (ACLs), collecting and treating ground water, or removing the source of contamination.

The surface water in the drainage ditch to the east of the landfill will be sampled on a quarterly basis as part of the monitoring program. Monitoring will verify that discharges from the ditch are in compliance with Ohio Water Quality Standards, as described in the Ohio Administrative Code (OAC) 3745-01. A corrective action program will be implemented if contaminant levels in the ditch exceed these standards.

10.2 Site Access Restrictions

Efforts will be made to procure deed restrictions prohibiting ground-water extraction in the field west of the landfill and restricting disturbance of the landfill surface. The viability of continued farming immediately west of the landfill will be evaluated, and, if shown to be necessary, efforts would be made to prohibit such farming by imposition of deed restrictions. A 6-foot fence will be placed around the landfill, the drainage ditch to the east, and the field to the west to limit site access. The location of the fence is shown on Figure 6.

10.3 Management of Surface Debris

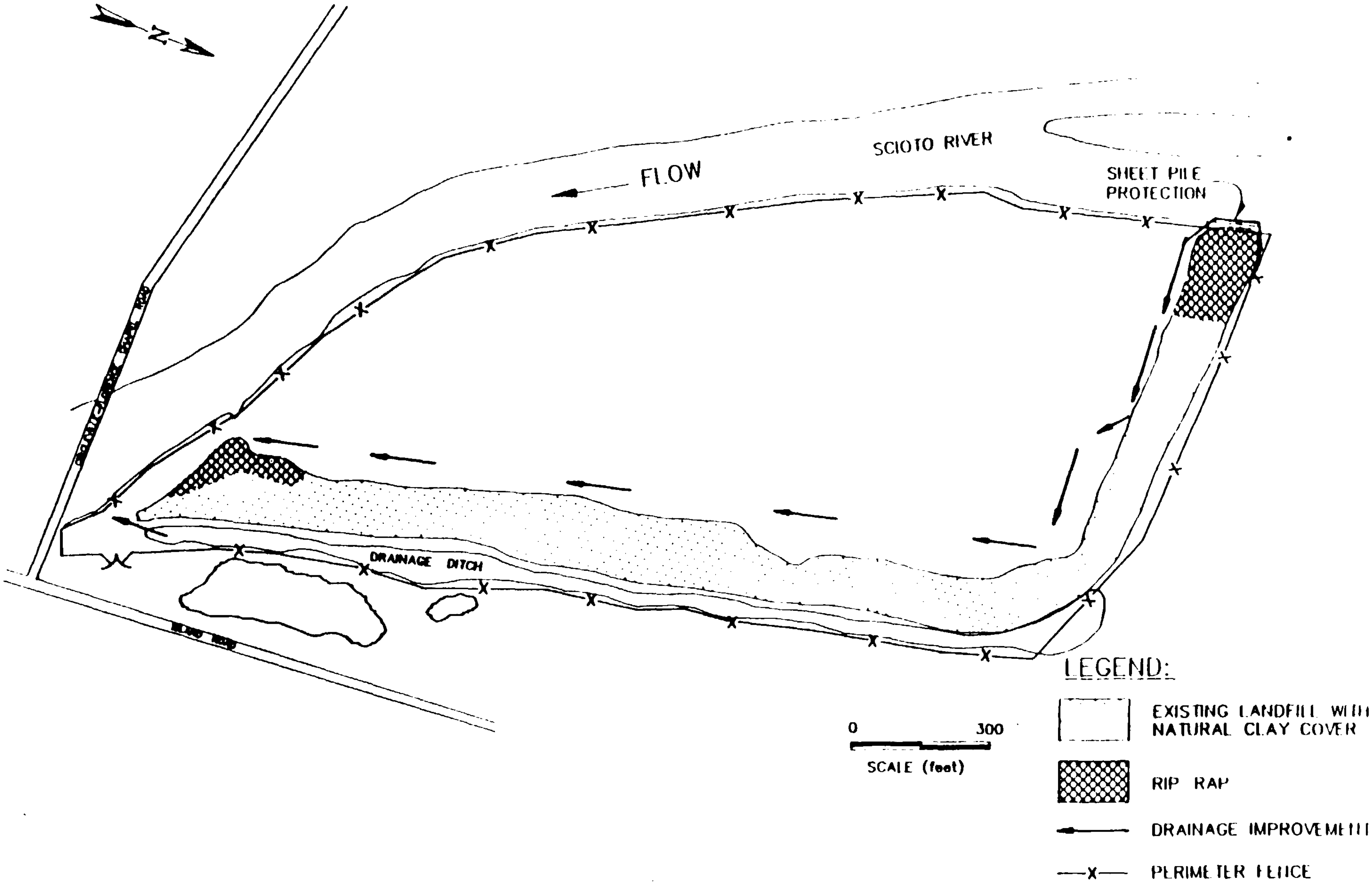
The landfill area and its immediate vicinity will be cleared of surface debris. Most of the currently exposed material consists of shredded or rolled plastic film, but rusted and partially decomposed remains of appliances, discarded tires, domestic waste, and empty drums are also evident. The visible waste items will be removed from the site by a front-end loader, placed in a lined truck, and transported to a suitable hazardous waste landfill. If the debris is determined to be nonhazardous, it will be disposed of in a solid waste landfill.

Trees on the landfill will be cut down with chain saws, and tree stumps will be ground down to the land surface. Smaller vegetation, less than 2 feet in diameter, will be cut down with mechanical equipment such as bush hogs. As much subsurface vegetation as feasible will be removed, without exposing significant amounts of waste. Exposed cover will be treated as necessary to prevent tree growth through the new cover. All vegetative material will be hauled to a local landfill unless tissue samples indicate that materials are potentially hazardous. If potentially hazardous, this material will be disposed of in an approved off-site hazardous waste disposal facility.

10.4 Erosion Control and Drainage Improvements

Erosion control will be provided for those areas of the landfill prone to the scouring effects of flood waters. The areas most likely to be subjected to these effects are the northwest

FIGURE 6. - SITE ALTERNATIVE 4



and southeast portions of the landfill that abut the Scioto River. A system of armor stone (riprap) will be used in these areas to supplement the erosion resistance provided by the new cover. This riprap will be placed on the landfill in areas shown on Figure 6. If riprap cannot be effectively placed on steeper slopes, sheet piling will be used to anchor the riprap. If sheet piling proves ineffective, a concrete wall may be used.

Site drainage will be improved to prevent ponding of water against the landfill. The area between the landfill and the river will be regraded to allow water to drain away from the landfill. The site will also be regraded to allow for drainage flow from north to south to the river.

The drainage ditch on the eastern side of the landfill will also be improved. Where necessary, side slopes will be improved to prevent erosion. The high point between the north end of this ditch and the open field north of the landfill will be cut down to prevent ponding of water against the northern part of the landfill during high-water conditions. High points within the ditch will also be cut down to allow water to drain through the ditch. Sediments removed during this process, and possibly other contaminated sediments, could be dewatered as necessary and placed on the landfill surface prior to installing the clay cap. Removal of contaminated sediments will reduce the possibility of contaminated surface water discharges from the ditch to the Scioto River. The discharge pipe at the southern end of the drainage ditch will be replaced with a larger one. A 36-inch-diameter corrugated metal pipe will be placed under the southern end of the landfill and will discharge to the river. The point where the ditch meets the pipe will be lined with compacted clay and reinforced with riprap. The pipe will have a 2 percent slope to prevent blockage with sediments.

10.5 Natural Clay Cover Over Landfill

Prior to construction of the landfill cover, a detailed geotechnical investigation will be conducted to measure the properties of the existing landfill surface and of soil and clay used for the cover. The purpose of this investigation will be to determine the stability of these materials under flood conditions. The cover will then be constructed with side slopes flat enough to provide adequate stability when the Scioto River floods. Although there is no apparent need for a landfill gas collection system, this determination could be reevaluated as part of the geotechnical investigation. A soil gas study of the landfill could verify that VOCs are not present in sufficient quantities to warrant collection.

The landfill cover will be constructed in segments to minimize potential damage due to flooding during construction. Work on one area of the landfill will be completed before construction of the next area begins. After each landfill segment has been prepared, a well compacted clay layer, at least 24 inches thick, will be placed on the landfill cap and side slopes. The clay will be added in lifts, not exceeding 6-inches, and compacted before more clay is added. The clay layer will have a maximum permeability of 10^{-7} cm/sec. Each lift will be tested according to a stringent quality assurance program to verify that this specification is met.

A top soil layer at least 24 inches thick will be placed over the clay layer (Figure 7). This layer will also be applied and compacted in 6-inch lifts. The final cover will have sufficient horizontal-to-vertical side slopes so as to prevent failure during worst case flooding conditions. The entire surface of the completed cover will be reseeded, fertilized, and watered to assure plant growth. The plant species used will have root systems that are not expected to penetrate below the upper 24 inches of cover.

The cover will be inspected and maintained on a quarterly basis. The maintenance program will include regularly mowing the vegetation on the cap; inspecting the surface for cracks, settlement, ponding, and erosion; completing appropriate repairs to the cap; and repairing the fence. Repairs to all significant damage will begin within 30 days. In addition to regularly scheduled inspections, additional inspections will be made after flood events.

The landfill will also be inspected for leachate and methane gas production on a quarterly basis. If leachate production occurs that could potentially adversely affect public health or the environment, a leachate collection system will be installed and the leachate will be collected and treated. If methane gas production occurs that could potentially adversely affect public health or the environment, a gas venting system will be installed.

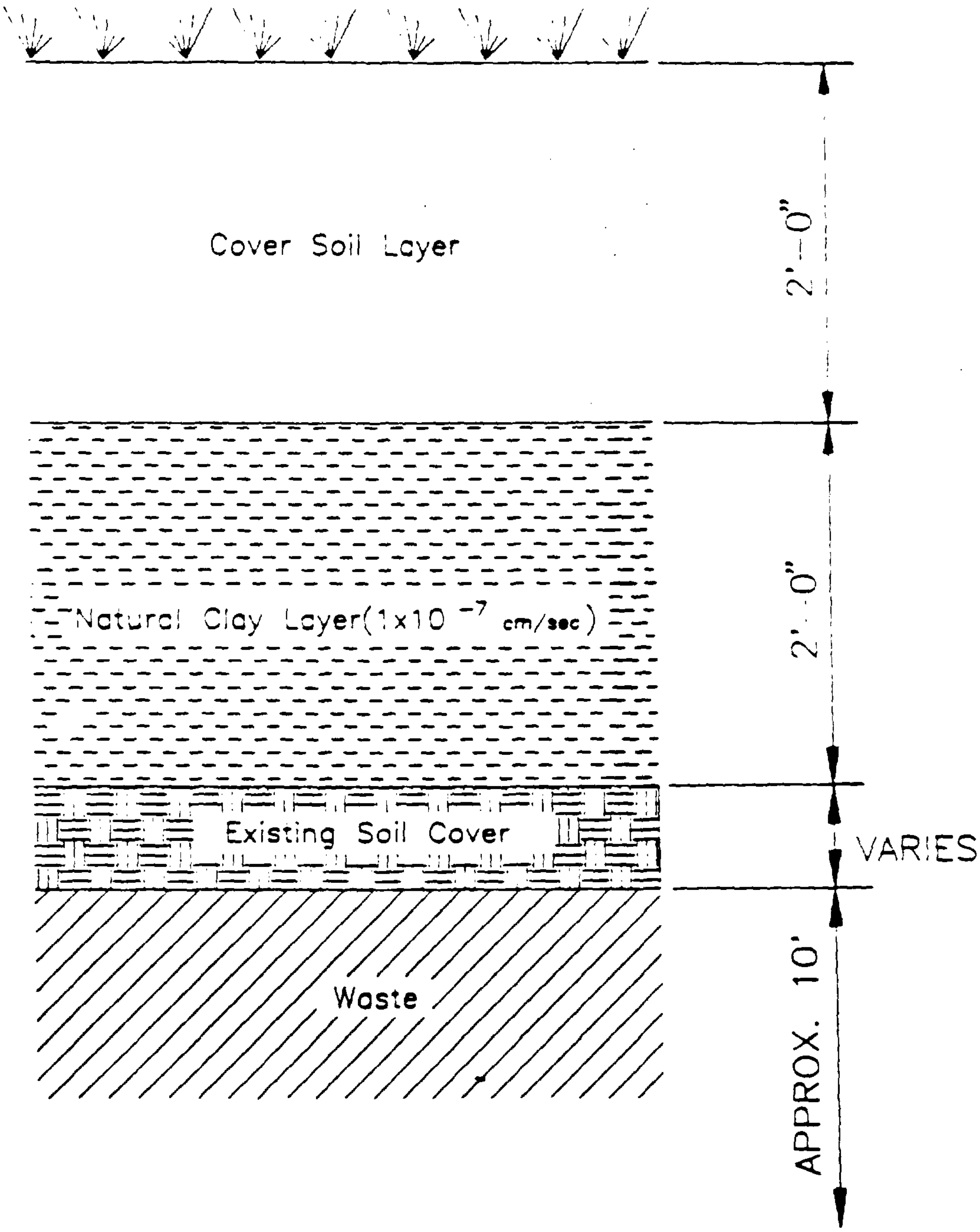
10.6 Reduction of Site Risks

The selected remedy addresses the major risks for Bowers Landfill as identified in the EA. Risks from ingesting contaminated soils will be reduced by covering the landfill (thus covering most highly contaminated soils) and by restricting access to the site. Soils in the field west of the landfill that contain lesser amounts of contamination will not be covered. The residual risks from ingesting these soils include an insignificant noncarcinogenic risk (HI of 0.24) and a carcinogenic risk of 4×10^{-8}. Risks from ingesting contaminated ground water immediately downgradient of the landfill will be reduced to zero by future ground-water use restrictions.

Alternative 4 also reduces potential long-term risks associated with the landfill. The low-permeability clay cover will greatly reduce infiltration of precipitation and flood waters, compared to the current cover. Thus, the mobility of contaminants remaining in the landfill will

FIGURE 7

DETAIL OF NATURAL CLAY COVER



be reduced. The cover will isolate waste within Bowers Landfill under a minimum 4-foot thickness of cover material and will be designed to provide long-term stability during floods.

11.0 STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Bowers Landfill site satisfies the statutory requirements of CERCLA Section 121. The selected remedy is consistent with the NCP, protects human health and environment, attains ARARs, and is cost-effective. The selected remedy does not satisfy the statutory preference for a permanent solution in that it leaves untreated waste on-site. Nor does the selected remedy reduce the toxicity or volume of wastes. However, source control and containment components of the selected remedy should significantly reduce the mobility of contaminants from the landfill.

11.1 The Selected Remedy is Protective of Human Health and the Environment

The remedial alternative selected for Bowers Landfill will reduce current and potential future risks to human health and the environment by the following means:

- Preventing exposure to contaminated soils by covering contaminated soils with a 4-foot-thick impermeable clay and soil cap and by fencing the site area. The cap and fence will be maintained on a regular basis, with an increased inspection schedule during floods.

- Preventing exposure to contaminated ground water by restricting access to downgradient property. Efforts will be made to obtain deed restrictions to prohibit extraction and use of ground water from this area.

- Limiting future ground-water contamination by reducing infiltration through contaminated soils and the landfill. The effectiveness of the cover will be evaluated by a long-term ground-water monitoring program. The program will require regular and systematic sampling of monitoring wells west and south of the landfill and possibly from residential wells south of the landfill.

- Reducing potential future exposure to wastes in Bowers Landfill by constructing a stable cover designed to withstand frequent flooding of the Scioto River.

- Reducing potential sources of surface water contamination for the Scioto River by removing contaminated sediments from the drainage ditch that is contiguous with the east side of Bowers Landfill. Discharges from the ditch will be monitored for compliance with Ohio Water Quality Standards.

11.2 The Selected Remedy Attains ARARs

The selected remedy will meet or attain all applicable or relevant and appropriate federal and state requirements. These requirements include:

- Ohio requirements for the closure of solid waste landfills (OAC 3745-27-09 and OAC 3745-27-10). The final landfill cover will exceed the required thickness of 2 feet and will meet all other substantive requirements within these regulations.

- Relevant and appropriate portions of RCRA requirements for closure of hazardous waste landfills with wastes in place. The low-permeability clay layer (maximum of 10^{-7} cm/sec) will comply with portions of the cover requirements in 40 CFR 264.301. The ground-water monitoring program will meet the substantive requirements of 40 CFR 264, Subpart F. The program will include a corrective action component that will be triggered if ground-water protection standards are exceeded at any point of compliance in the monitoring system.

- U.S. EPA requirements for floodplain protection, as described in 40 CFR 6, Appendix A, Statement of Procedures on Floodplain Management and Wetlands Protection. This regulation requires that construction in floodplains be done in such a manner as to minimize harm to the floodplain. Construction within the Scioto River floodplain is unavoidable in implementing a remedial alternative for Bowers Landfill.

- RCRA requirements for construction, operation, and maintainance of hazardous waste landfills in 100-year floodplains. The cover installed during remedial action will be designed and engineered to prevent washout of any hazardous wastes by a 100-year flood, as required by RCRA General Facility Standards in 40 CFR 264.18.

- Maximum Contaminant Levels (MCL) promulgated under the Safe Drinking Water Act. MCLs apply to public drinking water supplies serving 25 or more people. While not applicable to ground water immediately downgradient of Bowers Landfill, MCLs are relevant and appropriate for assessing ground-water contamination levels. Current contaminant levels exceed MCLs in two monitoring wells -- benzene in one well and barium in a second well. However, average ground-water concentrations were well below MCLs. By reducing infiltration of precipitation and flood waters through the landfill, Alternative 4 should eventually reduce contaminant concentrations below the MCLs in all downgradient wells.

- Ohio Water Quality Standards listed in OAC 3745-01. Discharges to the Scioto River from the drainage ditch east of the landfill will be monitored to verify compliance with these standards.

11.3 The Selected Remedy Is Cost-Effective

Alternative 4 represents a cost-effective remedial alternative for Bowers Landfill. This alternative attains the same reductions in current risks from soil ingestion and ground-water ingestion as Alternatives 5 through 8, which are considerably more expensive. Alternative 4 also provides an adequate degree of long-term protection, compared to these more expensive alternatives. Although Alternatives 5 through 8 may offer slightly increased long-term protection, the relative cost increases outweigh the expected benefits. Additional components of these alternatives, such as a gas venting system, leachate collection system, synthetic membrane cap, or flood protection dike, do not increase the effectiveness of these alternatives in proportion to the increased costs. These additional measures are not justified based on current site conditions and contamination levels.

Alternative 4 has a higher cost than Alternatives 3 and 9. However, these alternatives do not achieve either the short-term risk reductions or long-term protection offered by Alternative 4. By providing a degree of protection that cannot be achieved by less costly means, Alternative 4 is cost-effective.

11.4 The Selected Remedy Utilizes Permanent Solutions and Alternate Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

Alternative 4 is not a permanent solution to the public health and environmental problems identified for Bowers Landfill during the RI. It was not technically feasible to develop a permanent remedy for this site for several reasons. First, most of the material in Bowers Landfill consists of general refuse and municipal solid waste. Although the exact amount of hazardous waste placed in the landfill is not known, it is probably a small percentage of the total waste volume. Second, no operating records exist for the landfill. Thus, it is not feasible to identify locations where hazardous wastes might have been placed. Third, the relatively low levels of contamination found during the RI would not be effectively reduced by treatment.

Because the selected alternative is not a permanent solution and will leave wastes in place at the Bowers Landfill, the effectiveness of this remedial action must be reviewed at least once every 5 years.

11.5 The Selected Remedy Reduces Toxicity, Mobility, or Volume of Waste Materials as a Principal Element

Alternative 4 will not reduce the toxicity or volume of contaminants within Bowers Landfill. However, this alternative will reduce the mobility of waste materials within the landfill. The FS report estimates that the low-permeability clay cap included in this alternative will reduce direct infiltration into the landfill surface by over 90 percent. This is much more effective than the current soil and vegetation cover. Reducing the amount of water that contacts waste materials within the landfill should reduce the mobility of these materials and the likelihood of future ground-water contamination.